Online English Vocabulary Learning on Different Systems for Non-English Speakers

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An empirical investigation to examine the usability issues of using adaptive, adaptable, and mixed-initiative approaches in interactive systems

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بسم الله الرحمن الرحيم

In the name of God, most compassionate, most merciful

Dedication

This thesis is dedicated to the most precious people in my life, my wife and my lovely family. I also dedicate this work to Dr. Khalid Al-Omer, Dr. Yasser Bamarouf, and several other friends who helped me with suggestions. I would to dedicate this work to the team at De Montfort University, including Dr. Giampaolo Bella and Professor Hussein Zedan.

Al-Shumari Mansour

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Abstract

The combination of graphical user interface (GUI) and usability evaluation presents an advantage to mastering every piece of software and ensuring perfect quality of work. The increasing demand for online learning is becoming more important, both individually and academically. This thesis introduces and describes an empirical study to investigate and compare how vocabulary can be learned by using different interactive approaches; specifically, a static learning website (with straightforward words and meanings), an adaptable learning website (allowing the user to choose a learning method), an adaptive learning website (a system-chosen way of learning), and a mixed-initiative (mixing approaches and techniques). The purpose of this study is to explore and determine the effects of these approaches in learning vocabulary achievement to enhance vocabulary learning for non-English speakers. The participants were Arabic speakers. The three levels of vocabulary learning activities were categorised as easy, medium, and hard. The independent variables (IVs) were controlled during the experiment to ensure consistency and were as follows: tasks, learning effects, and time. The dependent variables (DVs) were learning vocabulary achievements and scores. Two aims were explored in relation to the effects of these approaches to achievement. The first related to learning vocabularies for non-English speakers tackling the difficulties of the English language and the second related to studying system usability of learning English vocabulary in terms of usability measures (efficiency, frequency of error occurrence, effectiveness, and satisfaction). For this purpose, a vocabulary-learning language website was designed, implemented, and tested empirically. To fulfill these requirements, it was first necessary to measure two usability components (efficiency and effectiveness) with a within-subject design of n = 24 subjects recruited and, for users' satisfaction, a be-

tween-subject design of n = 99 subjects recruited, while investigating satisfaction with a system usability scale (SUS) survey. The results and data analysis were described. Overall, the results shown were all satisfactory.

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List of Abbreviations and Acronyms

HCI	Human Computer Interaction
GUI	Graphical User Interface
Chi-Square	Tests “goodness-of-fit” of data to model
ANOVA	Analysis of Variance
ASR	Automatic Speech Recognition
Mann – Whitney	A non-parametric test
L2	Learning a second language
SUS	System Usability Scale
e-Learning	Electronic learning
DV	Dependent Variable
Adp	Adaptation
IR	Information Retrieval
Accm	Accomplish time task
ISO	International Organisation for Stand-ardisation
ITS	Intelligent Toutring System
NH	Null Hypothesis

Chapter 1 Introduction

1.1 Introduction

In the past several years, a great deal of research has been conducted to enhance the field of learning a second language (L2). According to Carroll (1977), learning a foreign language as a second language is difficult and frustrating, requiring considerable effort [1]. Foreign language learning has been researched Cohen (1987), Weaver and Cohen (1990), Cook (2013) and Stoffer (2006). Cohen suggested and classified the ways in which vocabulary is learned to commit new vocabulary items to memory into four categories: rote-repetition, structure, semantic strategies and the use of mnemonics. Weaver and Cohen (1997) classified learning vocabulary into the following categories: keyword mnemonics, visualisation, rhyme/rhythm, language transfer and repetition [2]. Cook suggested linking L2 sounds to the sounds of L1 words, looking at the meaning of individual parts of each word, noting the structure of the parts, putting the word into a topic or category, visualising the word in isolation, linking the word to a situation, associating a physical sensation with the word and associating the word with keyword [3]. Stoffer (2006) classified learning in a strategic way, including the following strategies: authentic language use, creative activities, self-motivation, creating mental linkages, memory strategies, visual/auditory strategies, physical actions, overcoming anxiety and the strategy of organising words [4]. English has been taught at an early age education, learning English and associate its learning in early stage of age Saudi Arabia, which indeed shows the importance of English language in education. Most people are willing to learn English and speak the language frequently for many purposes, such as higher education and travelling. Others are seeking opportunities to live in English-speaking countries. Ashton-Hay stated that educators are challenged to find more effective ways of teaching English and helping culturally diverse learners create meaning, communicate and transform their knowledge and understanding into relevant skills [5]. AlShammari stated that research elements have changed, from previously focusing on what computers can offer to language learners to now focusing on how computers can best be used to facilitate the teaching of a language [6]. In contrast, Chapelle stated the following:

Various forms of the question regarding whether computers should be used for language teaching are echoed throughout this past decade, but during the 1990s the question gradually changed from "should the computer be used for second language teaching?" to "how can the computer best be used in language teaching?" [7].

Graves (1987) suggested that students learn new words independently, and expand their vocabulary over time which called procedure or strategies [8]. Muang defined investigation vocabulary as "any set of techniques or learning behaviour, in order to discover the meaning of new word, to retain the knowledge of newly learning words, or to expand their knowledge of English vocabulary" [9]. In that sense, some strategies were being promoted in the education process that involved computers in one discipline to promote new discoveries and new knowledge. Today, computers dominate our world, and it is hard for us to live without them. Apple Inc.'s co-founder, Steve Wozniak, said he believes "a day will come when computers and humans become virtually equal and human beings will change into mere human pets" [10]. With each new software application, there is a surfeit of features designed to satisfy every user.

Learning a second language (L2) in Saudi Arabia is essential and is compulsory for all students in the early stage of age. The importance of the English language in education encourages researchers to develop new ways of learning with the development of new technologies. Vocabulary acquisition in particular requires individual dexterity and proficiency. In the last decade, the introduction of human computer interaction (HCI) to education has changed the desired mode from classroom education to interacting with applications. In terms of learning a new language and a new vocabulary, the variety of meanings each word may have poses a challenge to students. For this reason, new approaches to learning a language are required. Such concepts as *customisation* and *personalisation* are becoming highly attractive [10].

Customisation is the ability to manually configure the interface, information or services according to user preferences [11]. Personalisation can be regarded as the rationale for a new mode of public service delivery that enables users to produce professional solutions that meet their needs [12]. Therefore, adapting learning to users' needs is essential [13]. A static learning platform involves the straightforward learning of words and their meanings, whereas an adaptable learning platform involves students in the learning platform. According to McGrenere et al. (2002), when users change a system, it is called an adaptable approach; when the system makes changes to itself based on user input, it is called adaptive; and when both users and the system make changes, it is called a mixed initiative [14].

Pedagogy assumes that individualised learning involves separate entities with unique goals requiring customised support [8]. According to McGrenere et al., to consider individualised learning, a unique setting for learning must be provided that is personally relevant; this implies that learners must take ownership of and responsibility for their process and surroundings. In contrast, personalised learning relies on three theories [14]:

- Constructivism views learning as a process in which people construct knowledge, concepts and competence on their own through their environments [15].
- Reflective thinking implies examining and exploring information presented for understanding and use; learners are also directed towards meta-levels of learning [16].
- Self-regulated learning puts the focus on the cognitive and communication processes through which learners control their learning [17].

Computer-based learning has great potential as a learning environment because it is available at any time and enables distance learning; moreover, because of its interactivity, it supplies a motivational environment. Dickey (2007) suggested that interactive learning environments allow learners to construct understanding by interacting with information [18].

There has been some debate in the HCI community as to which of these three approaches is best [19]. One side argues that users should be provided with easily predictable methods to manage their tools, while the other believes that they need the right adaptive algorithm to help them focus on their tasks, rather than on managing their tools [20]. Despite this debate, far too little attention has been paid to comparing the adaptable, adaptive and mixed-initiative approaches.

1.2 Research Scope

Recent research on adaptive, adaptable, and mixed-initiative systems has been motivated by many factors in different disciplines [21], including the following:

- The software complexity of applications is increasing, not only in learning, but also for different area [14, 22].
- There is an increasing problem with information overload when compared with the traditional approach to software applications, particularly on the World Wide Web [23, 24].
- An increase is needed in design interfaces, specifically those that match the needs and preferences of many users [25, 26].
- Screen control and other adjustments are needed [27].
- Prevents and provides a solution to language barriers and learning.

Adapting new technology to this study in learning concepts would change the goal of the study and the implementation. The evaluation of personalised e-Learning applications technology across L2 acquisition aims to:

1. Provide Web-based e-Learning for L2 (personalised learning environments). The study will do the following:
   - Examine the personalised e-Learning environment between static and adaptable approaches.
   - Compare e-Learning, adaptive, and mixed-initiative approaches.
   - Compare the four approaches (static, adaptable, adaptive, and mixed-initiative).
2. Evaluate the usability, which, in general measure; as ISO 9241-11 includes the cover of:

- Effectiveness[1] (the ability of a user to accomplish tasks while using the system) [28],
- Efficiency (the effect with a minimum amount of effort in performing tasks) [28];
- Satisfaction (users' subjective reactions to using the system) planned by utilising the SUS method implied using one comprehensive questionnaire to measure satisfaction, ease-of-use, effort, and consistency using the 5-point Likert scale[2] [29].

Additionally, two questions were addressed:

- How can a system be devolved to ensure its usability?
- How can the usability of the system be demonstrated and measured?

The measurements include the performance and vocabulary learnability of e-Learning for enhancing L2 learning.

1.3 Aims

The main aim of this study was to focus on the use of adaptation in different vocabularies for non-English speakers, apply adaptation techniques, and investigate the aspect of adaptation in enhancing the learning of English. In fact, the study aims to evaluate three interface approaches—static, adaptable, adaptive, and mixed-initiative—in terms of usability and their ability to motivate non-native speakers to learn the English-language. Achieving learning outcomes were incorporating with adaptation to the interface will provide feedback to those in the field of education in general, and computer science in theory and practice. More specifically, this study

[1] Effectiveness as a component of the usability model implies measurements such as efficiency, learnability, and user satisfaction [20].

[2] The Likert scale is a type of psychometric response scale often used in questionnaires; it is widely used in survey research [21].

aims to produce a set of empirically derived guidelines for designing more usable approaches to increase learner achievements in learning L2 language. In part, the aim of the initial experiment was to highlight and examine the usability of static, adaptable, and adaptive methods found on vocabulary-learning websites. More specifically, it investigated the significant differences among these approaches in terms of efficiency, effectiveness, and satisfaction.

1.4 Objectives

The research aims were addressed through three areas of experimental studies: the pilot study, the usability attributes of three platforms, and user satisfaction. Additional aims of this research were to:

- Highlight and describe the motivation, aims, and objectives behind adaptation in English language for different systems.
- Identify the research questions and obtain original research contributions.
- Explicate the thesis structure and empirically derived guidelines used in each environment.

The aim of this section is to shine new light on adaptation in terms of motivation in environmental learning zones, when and where they are used most often. In order to fulfil this aim, the initial objectives must be attained. The first is to implement a static online learning approach to learning vocabulary and evaluate the usability of this system in comparison with three experimental platforms to compare the interaction of the vocabulary learning in each platform. The second involves measuring learning achievement in each platform by interacting with learning style. Furthermore, experimental consideration provided sufficient evidence to both the learning field and the computer. Primarily, interaction with adaptation to support designing tasks with three levels of learning is increasingly difficult for determining the task design effect on usability. The learning tasks include three levels of learning items: simple, moderate, and difficult items, then antonyms and alternative items. Moreover, the scope of the research will expand beyond the notion of usability characteristics due to a source of variance in user attitude motivations need expansion on investigating user cognition and learning achievement.

1.5 Methodology

The following methodologies were adopted in this research for developing a suitable language online learning technique:

1. A study of current literature in the areas of computer science and psychology. Pure adaptation applications are of the most concern, relating to GUI and a number of direct empirical comparisons. The majority of these evaluations compared three interfaces. In addition, psychology theories which related to learning in general were used, such as constructivism, behaviourism, and pedagogy.

2. Comparative evaluation that relied on a number of participants randomly selected from the population and assigned to the four groups (one control group and three experimental groups). The control group is the static group, whereas the three experimental groups were given different treatments by interacting with adaptation in different levels; the key point is the design that affects usability factors, while the course materials were equivalent to all groups and observation only occurred in the interaction treatment.

3. The use of adaptation in e-commerce to increase advertising products and gain brand loyalty. Conversely, adaptation in learning vocabulary is meant to

increase learnability and to enhance and motivate learning. This allows student involvement to control their learning and helps them to overcome difficult-to-understand vocabulary.

4. Data used to assess users' views and behaviour. These were a post-questionnaire, a questionnaire, and automatic calculation.

5. First experiment: This was a comparative empirical study that aimed to investigate the usability and learnability of three interactive conditions: static, adaptive, and adaptable. Each of these was implemented separately as a Web-based learning application. The structure of the static platform was similar to that of many Web-based learning platforms. After estimation, these environments were tested independently by three separate groups of 33 subjects.

6. Second experiment: This investigated empirically the use of adaptable systems. Users were involved in choosing the learning activity from two conditions: learning by synonyms or antonyms. This environment was tested with 33 subjects.

7. Third experiment: This investigated empirically the use of improved learnability of best vocabulary from static, synonyms, and antonyms. The results of the second experiment indicated that difficult vocabulary may be learned with synonyms rather than with straightforward definitions. The system could customise vocabulary by time spent on a learning task and from the result of answering the question at the end of the session. This experiment was conducted independently using 33 subjects.

8. Guidelines: The results obtained from the experimental studies were compared and discussed to produce conclusions and empirically derived guidelines for the use of the static, adaptive, and adaptable approaches.

1.6 The main Hypothesis

This research evaluated the differences between groups in different platforms of adaptation techniques to explore the casual relationship between factors. The researcher focused on GUI usage to fulfil its importance in this research. Furthermore, the following questions needed to be answered:

The main hypothesis:

The overall aim is to evaluate the level of human computer interaction in commercial websites in order to enhance educational websites, and to explore the interactivities of learning vocabularies on different platforms.

In addition, the initial experiment aimed to elicit subjects' views of word knowledge, which differs from person to person. **Figure 1** illustrate overall environment [30]:

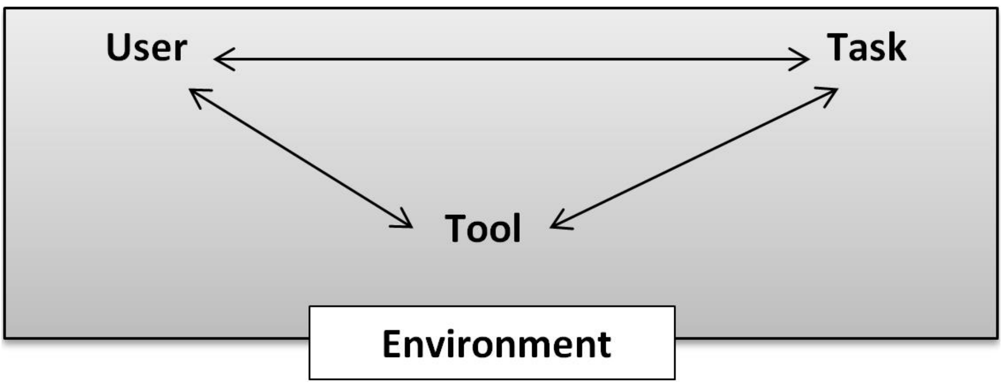

Figure 1: Overall environment illustration as adapted from [Judy Jeng]

Critical examination of the literature shows a lack of software and technology that support vocabulary learning. Therefore, the two hypotheses to be evaluated within the thesis, which link directly to the research question and **Figure 1,** illustrate the relation to environments as well as the research question broken into sub questions with respect to different areas of studies:

> Q1. How closely is usability attributes correlated with a vocabulary-learning environment?
>
> Q2. How can we enable the use of adaptation in online learning?
>
> Q3.What guidelines can be provided for designing more usable vocabulary interfaces?

In essence, this will explore whether an intelligent, adaptive environment which incorporates the ideas of adaptability and adaptivity can be devolved to aid the customisation and personalisation of vocabulary learning. Consequently, hypotheses formulation and experimental design were aligned to relevant areas of adaptation interaction. In particular, the study aims to measure the usability (efficiency, effectiveness, and satisfaction) and learnability of static, adaptable, and adaptive methods in a vocabulary-learning website. The comparative evaluation relied on a number of participants randomly selected from the population and randomly assigned to four groups (one control group and three experimental). The control group received no treatment, which is the static platform, whereas the three experimental groups received different treatments by using different techniques to interact with each system. The research is based on true experimental design[3] with three platforms—adaptable, adaptive, and mixed-intuitive—based on the literature review of related work; the following hypotheses are made to be tested by the study.

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[3] True experimental design is regarded as the most accurate form of experimental research, in that it tries to prove or disprove a hypothesis mathematically with statistical analysis.

This question can be broken down into sub-questions, as listed below, after specifying the dependent and IVs needed to carry out this experiment:

Q3-1 How efficient will be assessed online learning platforms be in terms of the function learning time, the function completion time, and the number of errors?

Q3-2 How effective will the assessed vocabulary online learning be in terms of the percentage of function learned and the percentage of tasks competed successfully?

Q4. How satisfactory will the assessed online learning vocabulary be in terms of ease of learning function and user satisfaction? Evaluate the three new approaches and analyse them to obtain results that help designers in the learning field and increase understanding in this area. Create questions that link to the learning vocabulary achievements and measure the level of vocabulary achieved.

1.7 Summary of Contribution to Knowledge

Until recently, little attention has been paid to learning vocabulary, and comparing techniques of adaptation, such as adaptable, adaptive, and mixed-initiative approaches in sake of learning. Although regardless of the debate in the field of human-computer interaction as to which of these approaches is preferred [31]. For example, arguments in e-commerce stated that users should be able to manage their tools easily and managing should be the directed to user, while, conversely, some insist that managing should be the antonyms, towards the development of right adaptive algorithms [32]. Despite the debate in e-commerce research, the trend is to focus on and provide a concrete understanding of the factors making some of approaches successful in one context and less so in other ways [19]. The core contributions of this research are summarised as follows:

1. The adaptation approach in this thesis presents a new method in the learning field, where no previous work has been done. It demonstrates where and when each approach can best be used for learning. The study determines how each approach can best be utilised.

2. The primary contribution is to provide an empirical comparison between the three approaches to decide which condition will best produce more learnability with the complexity of the vocabulary content. More specifically, it measures the effects of online learning vocabulary on user experience under static, adaptive, and adaptable conditions.

3. The second contribution is to provide empirical and static evidence that these approaches have an effective and motivating effect on online learning, especially to enhance the difficulties of the vocabulary.

4. This thesis proposes a solution to the problem of overcoming language barriers by measuring the study length of a single word and any error in response, then shifting to the next level. In the second level, synonymous, antonyms, or alternative learning solutions would be found and, if the same obstacle occurred, would shift to a third level to determine the best learning method. In the second level, better learning solutions would be sought from synonymous, antonyms, or alternative methods, and if the same obstacle occurred, it would shift to a third level, decide the best learning method, and apply it.

1.8 Critical Evaluation

The thesis proposes three solution of learning vocabularies; the first solution was to bring graphical user interface to user-focus area and involve him/her in choosing the way of learning as adaptable system approach, the adaptability occurs on the way user chosen to learn and time measurements. The second solution was to bring graphical user interface to user-focus area and involve system in choosing the way of learning as adaptive system approach, the adaptivity occurs systematically accounting number of mistake appeared and time measurements during learnings session. The thirds propose solution was a mixed-initiative solution which mixing the two previous approaches and the adaptability does not involve the user intervene direct to the interface, but depending upon previous and measurements. These solutions were investigated empirically in three usability studies. The experiments have shown that adaptable approach on levels of learning easy, moderate, and difficult vocabularies can significantly enhance learning vocabularies compared with static system, also shown a significant level towards adaptive approach in three levels of learning. Adaptive approach have shown that vocabulary learning on three levels can significantly enhance compared with static approach and shown significant compared to adaptable approach in learning difficult words. Mixed-initiative approach has shown significant results compared in all others in all levels.

1.9 Thesis Outline

This thesis produced a total of six chapters as follows: **Chapter 2** reviews the current literature survey; **Chapter 3** studies adaptation aspects in most general domains; **Chapter 4** integrating theory and practical implementation; **Chapter 5** reviews experiments and data presentation, and provides an analysis of findings; and

Chapter 6 collects the entire work and provide guidelines for designers and individual users to make software more usable.

Chapter 1: Introduction to the Thesis

This chapter provides a brief introduction to the research work carried out, including aims, objectives, scope, methodology utilised, and the contribution to knowledge. The aims affirm why this research effort is undertaken and objectives specify how to address these aims. The contribution specified is related to HCI.

Chapter 2: Literature Review

This chapter reviews all the relevant research in the various areas related to the study aims. In particular, it describes research theories, learning, and online learning. The purpose of the review is to help establish a general understanding and motivation for the study.

Chapter 3: To Study Adaptation Aspects in Most General Domains

This chapter outlines the use of adaptation in different areas and both the advantages and disadvantages of its usage.

Chapter 4: Integrating theory and practical implementation: Theory and Practical implementation.

This chapter describes most learning theories that associated to learning and most advanced techniques in online learning.

Chapter 5: Experiments and Data collection

This chapter describes the experiments carried out and the research approach; discusses the applicability of quantitative research methodology; and articulates the phenomenological research with participant confidentiality.

Chapter 6: Conclusions and Guidelines

The final chapter provides a concluding discussion of topics, including the limitations and contributions of the research. Some areas for further work are also suggested.

In addition, six appendices are provided:

Appendix A: Questionnaire and Questionnaire of Experiment: Uses the SUS Survey and shows the questionnaire used during experiment one.

Appendix B: Screenshot for the Entire System: shows the most screenshots for the system and subsystems.

Appendix C: All referencing for table: 3 – Adaptive presentation: methods, technique and system.

Appendix D: Questionnaire for Experiment Two: provides questions for the second part of the system.

Appendix E: Database Design for the System.

Appendix F: Word List Randomised for Three Comparative Systems: provides table list of 40 words in pilot test experiment.

Appendix G: Randomised World list complexity and system used.

Appendix H: Raw Data of Achievement Test on four systems.

Appendix I: Word List Survey for level of difficulties.

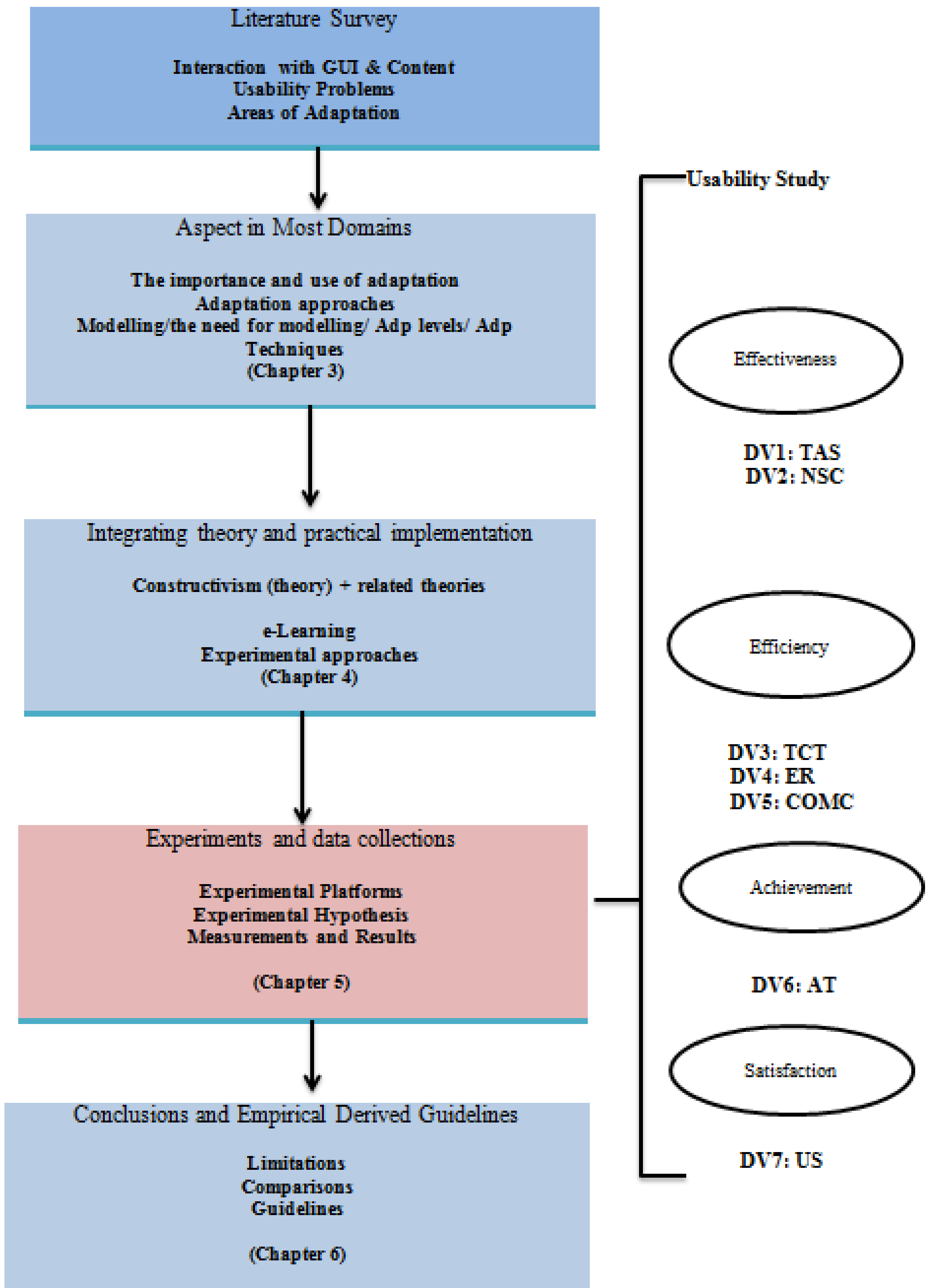

Figure 2: Structure of the thesis and experimental steps undertaken in the study

Chapter 2: Literature Review

2.1 Introduction

English language was considered a superior language being an international language and the language of science and technology [33]. Taught English earlier a little importance was given in teaching and learning of English in Saudi Arabia education system [34]. From 1960 to early 1970, computer the user interaction with computer was upon on command line interface, program execution depended on user command accuracy typing, in 1968 changes has begun when Douglas Engelbart developed a multi-windows called oNLine System (LLS), from that time computer mouse has discovered and replaced the command line, which was the start of interaction [35]. Education and training is becoming a huge business worldwide [36]. State interaction with computer will lead to discover usability. Usability as it is defined by the International Organisation for Standardisation (ISO) "the effectiveness, efficiency and satisfaction with which specified users can achieve specified goal in particular environment" [37].

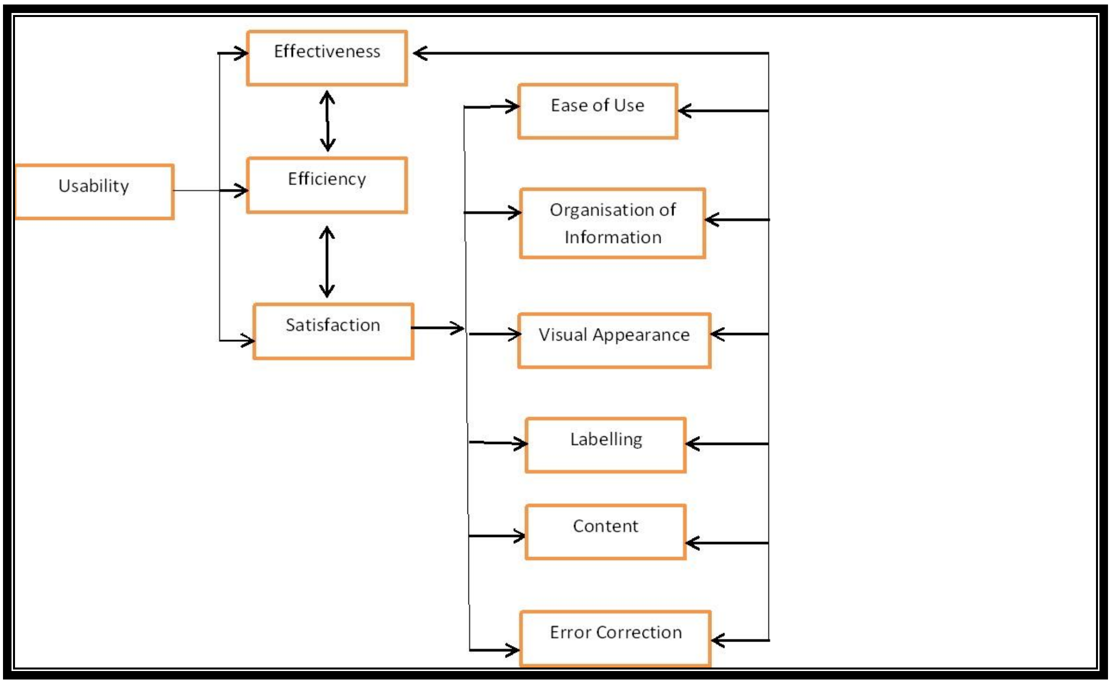

Figure 3: Usability structure adopted and modified from a model of usability by Judy Jeng [38]

Usability can be viewed from two angles: one angle is the user view and the second angle is the system measurement. From the user perspective view, the “Satisfaction” structure in **Figure 3** implies six considerations to meet users’ satisfactions. System measurements were collected and evaluated in this study. Such commonly used terms as online learning, distance learning, and Web-based learning are synonymous and will be used interchangeably throughout this thesis; however, each term has a slightly different meaning. It is important to know software techniques because they give a user the ability to deal with the system. For instance, Hagen has defined personalisation as the ability to provide content and service tailored to individuals based on knowledge about their preferences and behaviours [39]. Website applications have been developed, such as Google, Yahoo, and Alta Vista, as well as news websites, such as CNN and Google News. All these websites are evidence of the increased use of the Internet. In fact, it indicates the growth of information tremendously. This growth creates an excess of information for users [40]. Technology provides answers to help Internet users search more efficiently, providing such tools as the Google search engine [41]. These tools provide personalised mechanisms to help users easily filter irrelevant results. Individuals and organizations presently use online learning, distance learning, online learning, and Web-based-learning. Therefore, modern organisations have seriously considered tracking the changing preferences of learners over time, and more importantly, have emphasised rethinking the role the learner can play in innovation. To develop suitable methods for personalised learning applications, it is necessary to have a clear understanding of several research areas. This begins with an overview of personalisation and its advantages for learning. Each technique of personalise for learning and its application in Web-based learning is then introduced. This is followed by a detailed survey and discussion of the techniques that support Web navigation and knowledge construction, with attention paid to their limitations. Last is a presentation of viewpoints on how to overcome these limitations. It is important to consider the security issues along with access control and software evolutions. Access control involves the relationship between system policy and the application code when a security concern is raised.

2.2 English vocabulary learning

Vocabulary is critical important to learn for second-language learners. Huckines, and Coady (1999) concluded that vocabulary knowledge and ability to read are the most important component to be considered while preforming good second language learning [40]. Khan (2011) stated that teaching English is challenging task and English language in Saudi Arabia serves a very limited purposes with its vast indispensable for social and technological development issues [41]. Assalahi stated that the foreign-run companies such as Aramco (founded 1933) have had greatest impact on Saudi economy which commenced the learning of English in KSA [42]. Khan stated that teaching/learning of English is incomplete without teaching and focusing on the word with concentrating on Synonyms which are the most important aspect of teaching English vocabulary [43]. Khan has pointed out that feature of word different such feature is rare in Arabic language, but commonly in English such as using (Affixes): Prefixes and Suffixes is sound difficult in the beginning, but after made serious attempts to understand the neutral the target language will be achieved [43]. This study was solely aimed to be applied on Saudi students, due to the fact and the neutral of Saudis. In that sense of generalising the results may not suitable for any language.

2.3 Interaction with GUIs and Content

The main concern of HCI is to enhance and improve the usability of computer systems [44]. The ISO describes usability as the "the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in particular environments" [37]. The interaction between human and computer has many factors to succeed usage and achievements to particular goals in smooth conditions. Over the past years, researchers have looked at relationships between language characteristics and their performance with relation to the learner [45-47]. In this sense, researchers have agreed that a variety of language online learning strategies have the potential to facilitate language learning [48, 49]. See **Table 1** to examine the language online learning strategies employed by learners of English as a foreign language or as a second language and the findings which have been used to define and classify language online learning strategies.

Table 1: Classification of learning strategies

Cohen classification (1987)	Weaver and Cohen (1997)	Cook (n.d.)
• **Rote-repetition**: repeating the word and its meaning until it seems to have stuck. • **Structure:** analysing the word according to its root, affixes, and inflections as a way to understand its meaning. • **Semantics strategies:** thinking of synonyms so as to build a network of interlinking concepts, clustering words by topic group or type of word, or linking the word to a sentence. • **The use of mnemonic devices:** to create a cognitive link between unfamiliar of growing languages word its translation by means of a cognitive mediator.	• **Categorisation:** e.g., according to meaning, part of speech, formal vs. informal language forms, alphabetical, or types of clothing or food. • **Keyword mnemonics:** e.g., finding a native language word or phrase with similar sounds, and creating a visual image that ties the world or phrase to the target language. • **Visualisation:** e.g., through mental images, photographs, charts, graphs, or the drawing of pictures. • **Rhyme/rhythm:** e.g., making up songs or short ditties. • **Language transfer:** e.g., using prior knowledge of native, target, or other language structure. • **Repetition:** e.g., repeating words over and over to improve pronunciation or spelling while trying to practice the words using all skills.	• Link L2 sounds to sounds of L1 word. • Looking at the meaning of part of the word. • Noting the structure of the word part. • Putting the word in a topic group. • Visualising the word in isolation. • Linking the world to a situation. • Creating a mental image of the word. • Associating a physical sensation with the world. • Associating the world with a keyword.

2.4 Usability Problems

It is becoming increasingly difficult to ignore the growing number of functions in software applications in different areas. This section looks at those areas. Little attention has been paid to personalised approaches in learning. Specifically in user interface, Alsuraihi stated that GUI has six areas of hold interaction: pull-down menus, toolbar, toolbox, workplace area, properties-table, and status-bar [50]. Conversely, designers and software developers produce flexibility by providing multiple functions and styles [51]. In addition, "the designer normally either clutters the screen with many options or builds a structure where users must remember the existence of 'invisible' options and the sequence of actions that lead to them" [52]. Furthermore, the focus is mainly on visual interaction and negating the other channel [53]. Using only the visual channel to convey all kinds of information increases the complexity [54]. This in turn makes users feel nervous, confused [52], and even oppressed [55]. One of the problems discussed is that crowding of interfaces causes users to experience information overload [56, 57] so that they miss important information because "our eyes cannot do everything" [58]. In addition, there are usability problems with visual-only interfaces. These include the complexity of information presented to the user [59], button slipping-off [60, 61], closure [61], interface intrusion into tasks [62], and missing the selection of menu items because of inadequate feedback [63, 64]. The usability problems include most problems in areas of GUI and many areas that can influence the enhancement of the interface.

2.5 Multimedia and Multimodal Interfaces

Today, with the discovery of new software and with robots employed to find multichannel areas, people can access information through different devices [65]. Additionally, a combination of two or more user-input modes is available, such as speech, pen, touch, and more with multimedia system output [66]. Multimodal and multimedia both increase bandwidth [67], but there is an important distinction between them. Users communicate with systems through different channels, such as visual and audio, by using different modalities, such as visual display, audio, tactile, and feedback [68]. Input modes include speech, pen, touch, manual gestures, gaze, and head and body movements. Conversely, these examples indicate the importance of the interface and its development.

Because interaction mode can be a difficult choice and multimodal choices can differ from user to user and from time to time [65], the choice of the interaction suggests a need to personalise interaction modes for each individual user. Meanwhile, multimodal systems have developed rapidly during the last decade [69]. For instance, the MMI2 system[4] [65] is a way of designing computer networks using natural language (English, French, or Spanish) through a keyboard, command language, graphics with direct manipulation, and mouse gestures. Another system called VoicePaint (Nigay, 1993) is a graphics editor application implemented on the Macintosh using Voice Navigator, a word-based speech recogniser board [70]. While drawing a picture with a mouse, the user can talk and ask the system to change the attributes of the graphics context [71]. Aircraft cockpit designs impose high loads on human visual senses for displaying flight information, such as altitude, vertical speed, airspeed, and other information. The heavy visual workload and physical conditions influence the cognitive processes on the display. To date, human-computer interfaces have relied on visual channels to present information to the user [64]. One way of reducing the complexity of a GUI is to reduce the workload on the visual channel. Some researchers have successfully [72] overcome infor-

[4] MMI2 is a Multi-Modal Interface for Man Machine Interaction with knowledge System.

mation overload by using other sensory modalities, such as non-speech sound [73] and haptic technology [74, 75], to provide feedback.

2.5.1 Auditory Solutions (Speech and Non-Speech)

The interface displays the initial functions of the programme. Auditory refers to the use of sound in interfaces. This sound has been restricted to providing auditory alerts to users, but many users find that alert sounds (e.g. bleeps) are “distracting and irritating” [76]. Buxton claims that “by effective design, we can reduce the noise component and increase the information-providing potential of sound” [77]. The advantage of using sound was declared by Gaver, who argues that “a good first reason to use sound is simply because it’s there…sound is more than just an available resource”. Sounds like car horns can have an impact on one’s privacy. However, “it’s important plays an integral role in our daily life and encounters with the complementary with vision” [76]. Combining visual and audio channels can significantly improve usability (e.g., [78, 79]). For example, Gaver proposes that “sound should be used in computers as it is in the world, where it conveys information about the nature of sound-producing events”. In addition, “using both visual and audio channels would increase the bandwidth of available information” [80]. Usability is not attentive with adaptation, but also concerns visual, auditory, and other functions.

2.5.2 Earcons

Earcons[5] are a common feature application structured from beeping [81]. Blattner et al. [82] describe how to encode specific information into sound. The spread of research in the usability field implies that non-speech sounds (Earcons [82, 83] and

[5] Earcons are structured audio messages used to provide information about an object, its operation, its interactions, and the coding of its location, which imply a relationship between objects and the display [64].

auditory icons be used to improve the performance and usability of GUIs [57, 84, 85]. Brewster et al. conducted detailed investigations of earcons and showed that they are an effective means for communicating information around the interface [86, 87]. Brewster evaluated earcons to demonstrate that their use in interfaces could reduce the workload and to provide guidelines [88]. More recently, Brewster has designed guidelines for the presentation of the concurrent earcons to help designers create interfaces that are more effective at communicating information to users [89]. He suggested that designers should reduce the number of concurrently presented earcons as much as possible. However, some problems have been encountered because the adding of sound by designers who are not sound experts can make the sounds ineffective [90, 91]. Additionally, using earcons requires a high level of concentration and the development by users of a perceptual context [92-95], which may lead users to interpret messages incorrectly [96].

2.5.3 Speech Recognition

Automatic Speech Recognition (ASR) is the process of a computer which is programmed to understand human speech [97]. Bolt [98] has worked on to encourage many others to develop multimodal systems duty to the fact the importance of sound use can be beneficial, such as hands or eyes[54]. Speech recognition is important because it uses a natural human function and may be particularly useful for some people, such as those who are physically disabled [99]. There are several systems which use sound on their interfaces. For example, INFOSOUND[6] sound is a composition system which enables users to create and store auditory stimuli and associate them with application events [100]. It has been used to create auditory interfaces for

[6] INFOSOUND is a Yamaha proprietary technology that transmits digital information modulated into sound signals. Using the very high frequency sound range enables the transmission of data at frequencies that are almost inaudible to the human ear [85].

two applications—a telephone network service simulation and a parallel computation simulation. The auditory interfaces helped users to detect multiple event sequences that were difficult to notice visually. Another example is SPHINX[7], the first accurate, large-vocabulary, continuous, speaker-independent speech-recognition system [101]. It was designed to deal with speaker and environmental variation, and to improve speech recognition. Performance was improved and the word error rate was reduced significantly by the SPHINX-4 speech recognition system [82]. POCKETSPHINX is a more recent version with a 1000-word vocabulary speech recognition system used for facilitating hand-held devices [102]. However, speech recognition use is countering some difficulties. As Shneiderman stated that, "humans can easily speak and walk, but they find it harder to speak and think"[19]. In addition, there were some errors linked with the limitations of speech-recognition systems. Forsberg recounts some of the difficulties that associate with ASR, such as noise, ambiguity, speaking style, and controlling speed of speech[97].

2.6 Modern Mobiles

A hand-held device graphical user interface such as mobiles on with "touch screen" or "static screen" having specific features for individual use. These features include zooming in required area of use with desired feature. Display zooming recognition for small individual user request must fulfil user need. Choi stated that configuration to display plurality function of potable data device corresponding to plurality feature and displayed at a scale size in which can be controlled and recognisable [103]. Oblinger (2010) stated that constant mobility and availability of language are digitally oriented [104]. Chen and Chung (2008) developed an English vocabulary system to extend individual memory cycles to promote better learning and the results

[7] SPHINX is a large-vocabulary speaker-independent continuous speech recognition system [86].

were indicated that memorising English words via mobiles devices were theoretical way to enhance English acquisition [105]. Mobile learning (M-learning) has to deal with the acquisition of knowledge using mobile devices as a pervasive learning [106]. Godwin-Jones (2011) concluded that significant software enhancements the iPhone was released in 2007 with a great usability functions on Web browser, Mobile Safari was coupled with high-resolution screen, a more powerful processor, more inter (RAM) memory, and fast internet connectivity [107]. Hence, many studies were carried out in order to increase efficiency of learning English vocabulary [108, 109]. Saran, Cagiltay and Seferoglu's study, results showed that learners specified positive feedback to the use of mobile phones in language learning [110, 111].

2.7 Summary

This chapter has provided a review of the literature survey related to online learning and vocabulary learning in a second language (L2), as well as the interaction in HCI, including the personalisation of content and interfaces. In static technique uses speech recognition, earcons, multimedia, and multimodal have been reviewed to point out the mechanism of interaction in GUI. First, most of the approaches that exist today are either purely adaptive or adaptable. Second, the mixed-initiative approach is quit used with little limitation. However, different learning and application studies have been reviewed to show how effective those approaches are in solving interface problems. These studies also involve encouraging learning achievements to better motivate and enhance learning. For example, direct comparisons have been considered between adaptive and adaptable, static and adaptive, and mixed-initiative and adaptable approaches. In addition, some features used as part of an application, such as sound, (auditory icons and earcons) and speech have been reviewed to show how effective these approaches are in solving the problem of interfaces.

Some results of previous studies of the adaptive and adaptable approaches in different areas in e-commerce have shown a conflict as to which approach is most able to reduce the complexity of software applications in user interface and Web content. While many studies showed the strengths and weaknesses of these approaches, there has been very little investigation on the use such techniques to be implemented in different domains to encourage researchers and designers to look at usability in different ways while problems of GUIs and content will already be included. There is a need to thoroughly investigate the use of sound as input and output in personalisation because there is evidence that combining different senses (such as visual and auditory) could significantly reduce the complexity of both GUIs and content. Far too little attention has been paid to dealing with adaptation in online learning with an optimistic instead of looking to the approaches for solving the complexities of GUIs and content through any approaches, such as mixed-initiative. There has been no work evaluating the depth of the mixed-initiative approach to GUI and content; this is a new area of research discovery. The exception to this is one direct comparison of a mixed-initiative approach to GUI customisation with either the adaptive or adaptable alternatives [112]. However, there is a suggestion made by researchers that mixed-initiative techniques can improve performance [113-115]. The following chapter attempts to answer the first part of question one presented in relation to the main aim of this thesis (see section 1.3). Therefore, it sets out the hypotheses used to conduct the first empirical investigation in this work to investigate which of the personalisation approaches (adaptive, adaptable, and mixed-initiative) to Web content in online learning users prefer, and why.

Chapter 3: Adaptation Aspects in Most Domains

3.1 Introduction

The aim of this chapter is to understand and investigate most aspects of adaptation, including what it means and why and where it is used. There was some debate concerning this area in e-commerce applications. Furthermore, e-commerce has benefited from such techniques, which might be delivered to learning domain to enhance learning and to improve learning achievement. Focusing in this area is particularly important because this method has grown in the learning domain and the industry is obligated to interact with this growth.

3.2 Aims and Objectives

The aim of the initial chapter was to understand adaptation and the importance of its used in different domains. The survey of the adaptation area is used to obtain an overall view of adaptation from different areas, such as e-commerce, and to attempt to shift this knowledge and these techniques to learning vocabulary with interaction and motivation. The user's evaluation of usability through usability components and suitable data analysis assists in finding usable, distinguishable software that can be shifted and changed.

3.3 The Importance and Use of Adaptation in GUI

What does adaptation mean? Oxford dictionary has defined adaptation as "The action or process of adapting or being adapted" and the example given is "the adaptation of teaching strategy to meet students' needs" [116]. In that sense, it is a mutation from one situation or process to another better situation or process to satisfy the whole situation or process. Adaptation in computer science, as defined by Wikipedia [117], is a process in which an interactive system (adaptive system) adapts its behaviour or individual users based on information acquired about its user(s) and its environment [11]. It has been widely used in many domains, such as networks in multilayer perceptron, in the artificial neural network to model and map input data onto a set of appropriate outputs, as another means in the interfaces in general, and as an example in a multilayer neural network controller [118]. This will address experimental techniques adaptability, adaptivity, and mix-initiative approaches. GUI adaption influences the task performance and user satisfaction [119]. Adaptation in learning has many different polymorphisms, such as Adaptation and Learning Using Multiple Models, Switching, and Tuning, which are related to adaptive control systems that can learn to operate in dynamic environments to control non-linear systems with robotic control [120].

It is important initially to have an understanding of adaptation and filtering and to know the difference between them. Javier stated that GUI is a key role in human-computer interaction and allowing information exchange with improved communication between end-users and the system for user demand [121]. For this research, it is important that the techniques applied adapt to user needs. There are some techniques for the GUI component and behaviour to abstract the level of interaction in runtime and users' needs, but this goes beyond the scope of this research. The importance of adaptation is to rely on the technique used to allow the software developer to implement software in whole or in part to improve the system. Every day, there are developments in evolution and new research for improving or enhancing system quality. New research exists for new GUI architectures on runtime adaptation and in dynamic adaptation, splitting GUI, menus, ubiquitous environment, etc. In the near future, we may see adaptation in every corner of system development. GUI approaches that are important for fulfilling research needs are adaptable approach, adaptive approach, mix-initiative approach, personalisation, and customisation.

3.4 Adaptive Approaches

Granic and Glavinic stated that the development of system interaction began in the early 1980s and research was directed towards the development of adaptive interaction systems [122]. An adaptive system is capable of monitoring its performance, changing its parameters, and improving its performance, but some researchers [123] define it as an interactive system that changes its actions and behaviour as requested by the user, based on assumptions from information about the user. It is agreed that adaptive systems should learn from the actions of each user and then adapt themselves accordingly. In this sense, methods of adaptation and user modelling are important to complete knowing adaptation [122]. The first generation was for adaptive hypermedia to explore the adaptation of both presentation and navigation. The second generation was that of the Web, which extended the adaptive hypermedia and explored the selection of adaptive content. The last and most recent generation is that of the mobile Web, which raises new issues in system adaptation, such as location time, platform, and bandwidth [122].

3.4.1 User Modelling

User modelling is a subdivision of the interaction field that describes the process of building and modifying the collection of information about users and distinguishing among them by modelling them. User modelling can be defined as the process of acquiring knowledge about users in order to provide services or information adapted to their specific requirements [124]. The success of systems adaptation is determined by collecting internal information about individual users. This is a representation of user characteristics, such as age, gender, personality, mood, and special needs or interests, used by a system as the basis for adaptation. [125].

3.4.2 The Need for User Modelling

Modelling is an approach used to focus on understanding users. One drawback of this approach is that users come from many different backgrounds with difference in knowledge, interests, habits, beliefs, and age; they may have different achievements from time to time, or even more than one goal at a time. User modelling can be approached in several ways, such as asking users questions, observing their actions, using stereotypes, or combining these methods [69]. The need for user modelling is important in adaptation.

3.4.3 Collecting User Information

Kume stated that information about users can be collected in two ways: one is to conduct a question-and-answer session requiring the user to state his or her preferences and the other is to monitor the user's dialogue with an application [126]. Noghani indicates that to achieve the ideal configuration via computer-aided adaptation, users should clearly be aware of the user model and must access the information. However, collecting information about individual users presents many challenges, including usability and privacy issues. One technique involves the adaptation of the User Profile Manger, a platform for collecting information about individual users to avoid compromising their privacy [125]. This method of information collection involves asking users their opinions about particular topics and comparing their responses to those of other users, or recording all the movements and actions that users perform [127]. The problem with tracing and recording the data is that it is hard to analyse and interpret. Therefore, some systems prefer to ask users direct questions about their interests during registration [125].

3.4.4 Adaptation Levels

De Koch has classified two levels of technological adaptation : adaptive presentation (at content level) and adaptive navigation (at link level)[128]. Paterno and Mancini have classified an alternative framework for adaptation by adding layout features (such as font sizes, font styles, or colours) in the content [69]. With this addition, adaptation has three-levels of classification: adaptive presentation, adaptive navigation, and adaptive content. The adaptive content means having different content at the level of text, images, videos, or animations from which the system selects the content appropriate to each user's profile. Adaptive presentation involves changing the layout of the system, such as the interface elements, colours, interface size, font size, font style, image size, and number of images, while adaptive navigation involves changing the link appearance, or the number of links or pages.

3.4.4.1 Adaptive Presentation

The goal of adapting the interface is to allow users to use the system more efficiently with minimal error [129] . A well-known example of such adaptation in interfaces is provided by the Smart Menu feature introduced by Microsoft in Windows 2000 [129]. The objective of adaptive presentation is to adapt the layout (font size, colour, language) to the user's needs. Adaptive presentation methods and techniques are usually grouped with those of adaptive content. However, the adaptive presentation is made separately here to give the reader a clear view of it. Consequently, the methods for adaptive presentation are [69]:

- Text presentation, with the objective of adapting the system by providing text in the way preferred by the user.

- Multimedia presentation, with the objective of adapting all possible presentation and layout features, such as font size, font style, and colours, to the user's needs.

3.4.4.2 Adaptive Navigation

Adaptive navigation is a way of helping users finds a suitable path when information is overloaded on Web pages. There are five types of links presented [124]: those with non-contextual links, contextual links, index links, content pages, and links on local or global hyperspace maps. These non-contextual links are independent from the content of the page, involving a button, a list, or a pop-up menu. Brusilovsky added that contextual links are normally embedded in the content of the page and can be removed. Links from index and content pages are listed as an index and can be considered as comprising a contents page. Finally, links on local maps and on global hyperspace are located in maps, which enable users to navigate [124]. Brusilovsky has specified some methods used to support adaptive navigation, which are summarised below [124]:

- Global guidance helps users to find the shortest navigation path for the required function.
- Local guidance helps users to find one navigation step to follow from the current step.
- Global orientation helps improve user knowledge of the hyperspace in the current position.
- Local orientation helps improve user knowledge of the different navigation possibilities.
- Personalised views, which are adjustable and adaptive view, enable users to view and organise hyperspace from a personalised perspective.

Adaptive technique is divided into some direct guidance, sorting or adaptive ordering of visible links, adaptive hiding of links, adaptive annotation of links, and map adaptation [130]. Adaptive navigation techniques are classified into five groups according to the way they are used to adapt the presentation of links [124]. With direct guidance, the system suggests the next appropriate node or link, depending on the user's goals and needs. This technique can be applied to all kinds of links [124]. The sorting technique sorts all links on a page according to user need. This technique can be applied only to non-contextual links or indexes or to content pages. The hiding technique is designed to protect users from irrelevant links and content. The hiding technique can be utilised with all types of links. Adaptive annotation provides a description of each link in terms of where it will send the user and can be utilised with links of all types. Finally, map adaptation is a technique applied to a map or a graphical visualisation to a structured link [69].

2.4.4.3 Adaptive Content

Adaptive content uses three methods. The first method is hidden explanations, for which the goal is to hide irrelevant links and content from the user [124]. This method is used [69] to show additional, prerequisite, or comparative explanations. The second method is variant explanation (content variants), for which the goal is to either hide or show the content page, depending on the user's needs and preferences. The last method is sorting the content of a page.

Implementation requires certain adaptive techniques, including conditional item of text [124], for which each item of text is associated with a condition. The system will present a true condition. The stretch-text technique is based on extending the text of the current page so the system and the user can extend or collapse the text. This is a very useful technique and can be used to collapse any unwanted or irrelevant content presented to the user. With conditional fragments, a user model provides the information that helps the system to determine which information (fragment variants) should be presented to the user. A page variant is a relatively simple technique which can be applied to the explanation variant method. This technique involves providing two or more alternative presentations of the content of one page. Then, when presenting the page, the system will choose the appropriate content depending on a user stereotype. The most powerful technique of the adaptive content type is the frame-based approach, for which information is put into frames which are associated with rules to hide or show them. For example, **Table 2** shows systems that use a combination of methods by applying one or more adaptive content techniques [124]**.**

Table 2: Adaptive content, methods, techniques, and systems (taken from Brusilovsky)

Methods	Techniques				
	Conditional text	Stretch text	Conditional fragments	Variants page	Frame-based approach
Hidden explanations	C- Book ITEM/IP Lisp-Critic	MetaDoc KNAHS PUSH			EPIAIM PUSH
Variants explanation (content variants)	C - Book		Anatom-Tutor Lisp-Critic WING-MIT	Anatom-Tutor C-Book ORIMUHS SYPROS	Hypadapter
Sorting method					EPIAIM Hypadapter

(1) Hidden explanations: is a mothed used for adaptive content and refers to the goal is hidden to irrelevant links and content from user. This method utilised to show additional prerequisite explanations [131].
(2) Variants explanation: is a method used where adaptation is part of continent page and this part might be hidden or shown depending on user preference and need.
(3) Sorting methods which are used to sort content of a page as a more relevant content to user towards front of a page.
(4) Techniques of using adaptive hypermedia (P. Brusilovsky) – Conditional Text is a technique for content adaptation, simple but effective all information in the page is divided into several parts/chunks. Each part is associated with a condition or set of conditions on the level of user knowledge represented in the user model. During presentation the information about the concept of the system only presents as a part where the conditions evaluate to true.

(5) ITEM/IP refers to Intelligent Tutor Environment and Manual for Introductory Program. An intelligent learning environment for teaching and learning introductory programming by the mini-language approach.
(6) Lisp-Critic – Location identifier separation Protocol – Critics enhance incremental learning, this technique accosted with all information about a concept and divided in two into several chunks of texts. Each chunk is associated with a condition on the level of user knowledge represented in the user model.
(7) C-Book is an adapt presentation to the user background. These systems store several examples illustrating particular concept and offers the user the example which is most suitable to the user's previous experience and interests.
(8) MetaDoc is a technique is based on stretchtext which is a special kind of hypertext. In a regular hypertext, a result of activation of a hot word is moving to another page with related text.
(9) EPIAIM is frame-based technique used to implement methods except prerequisite and comparative explanation.

Table 3: Existing Adaptive Hypermedia systems classified according to application areas. [Taken from Brusilovsky and references are providing in Appendix: C]

Educational Hypermedia Systems	Anatom-Tutor, C-Book, <Clibbon>, ELM-ART, ISIS-Tutor, ITEM/PG, HyperTutor, Land Use Tutor, Manuel Excel, SHIVA, SYPROS, ELM-PE, *Hypadapter, HYPERCASE*
On-line Information Systems	Hypadapter, HYPERCASE, KN-AHS, MetaDoc, PUSH, *HYPERFLEX, CID, Adaptive HyperMan*
On-line Help Systems	EPIAIM, HyPLAN, Lisp-Critic, ORIMUHS, WING-MIT, *SYPORS*
Information Retrieval Hypermedia	CID, DHS, Adaptive HyperMan, HYPERFLEX, WebWatcher
Institutional Hypermedia	Hynecosum
Personalised Views	Basar, Information Islands

3.4.5 Adaptation Methods

In most general definitions, most researches focus on the adaptation strategy as a decision-making process which is characterised by the following attributes: what to adapt, when to adapt, why to adapt, and how to adapt rather than define the method, because there are different methods to achieve adaptation, each of which is based on a clear adaptation idea and can be implemented by using different techniques at a conceptual level. Adaptation methods are defined as a technique generalised from existing adaptation [124], which in turn is specified by a user model representation and an adaptation algorithm [69]. Stephanidis et al. defined it as an approach to adaptive systems, pointing out the difficulty in implementing changes when needed [132].

3.4.6 Adaptive Techniques

Adaptation is dynamic adjustment of the interface which means word system were supportive to users and helps users cope with system complexity in general [133]. When compared with the differences in the personalisation approach (which relies on each user's direct input to personalise a system to user needs and preferences), these techniques are required to hide or show the information, products, and services that users may need.

3.4.7 Filtering

Personalisation techniques are needed to use and predict users' personalisation needs, which are categorised by three filtering rules: rule-based filtering, collaborative filtering, and content-based filtering [134].

3.4.7.1 Rule-Based Filtering

One of the more popular techniques in data mining is association rule mining, which looks for items that appear in the data and are associated with other items [135]. Examples of this rule-based system, which described the data range from products to a Web page that a visitor has accessed are found in [25], [136], [137].

3.4.7.2 Collaborative Filtering

Collaborative filtering systems use information rather than ratings or preferences and the collaboration of like-minded users to predict certain user preferences as closely as possible [134]. An example of a collaborative filtering system is GroupLens [138], whose clients include Amazon.com [139]. Collaborative filtering has been used successfully for recommendation systems [140].

3.4.7.3 Content-Based Filtering

This technique is used for systems recommendation. In e-commerce and menu lists, this technique works by looking for items that are similar to the items those users liked or purchased in the past. There are several systems available for creating user profiles, included Firefly[8], whose clients include Yahoo, and Net Perception, whose clients include Amazon.com [141]. Content-based systems rely on content similar to user profiles already obtained [134], [135]. Thus, both collaborative and content filtering rely on user input, allowing them to be combined successfully [142].

3.5 Empirical Studies of Adaptive Approaches

Adaptable approaches are used when users are responsible for carrying out customisation, but adaptive approaches occur when the system dynamically customises itself on the user's behalf. According to Gajos, the first rigorous and successful study of adaptation was reported in 1985 [143] when Greenberg and Witten demonstrated an adaptive interface for a menu-driven application [144]. There are several commercial examples of adaptive approaches with the expansion of the Internet. For example, the Start menu in Windows begins few shortcuts, and additional sub-shortcuts are then created for the most frequently-used programs. Another commercial example of an adaptive system is MSWord 2000Smart Menus. When opened, these first display a reduced version of the full menu, which contains the frequently and recently used items. After a while, the Smart Menus will then extend and display the full version. When the full version is displayed, the position of items is changed, which requires users to scan the menu from top to bottom. Another study showed that more consistency could be attained with a split menu [145] for which the menu items are always visible and the frequently used items are moved to a top

[8] Firefly is a music recommendation system that was founded in March 1995 by a group of engineers from MIT Media Lab and Harvard Business School [114].

section of the menu, separated from other items by a horizontal line. The experiment, which had 38 participants, showed the benefit of replacing the frequently used menu items at the top of the list. According to [134], Amazon.com is estimated to use at least 23 different types of personalisation techniques. Amazon.com tracks users' navigation and selection behaviour and uses this to provide a "Page that you made". For registered users, the history will be retained and the system will monitor a user's behaviour and clicks.

There have been numerous attempts to evaluate adaptive interface techniques experimentally. For example, a controlled experiment examined two adaptation techniques applied to lists of textual selections [146]. The first was to highlight suggested items by changing the background colour and the second involved shrinking non-suggested items while allowing users to explore these minimised items by means of a virtual fisheye lens. The results showed that accuracy affected the overall user performance and the user's ability to locate items that were correctly suggested by the system. Another study examined the effects of predictability and accuracy on the usability of the adaptive interface. Their results showed that predictability and accuracy led to improved satisfaction and performance. In a controlled experiment using 26 participants, three adaptive graphical interfaces (split, moving, and visual pop-out) were evaluated against a non-adaptive baseline. The authors of this empirical study [69] compared their own results with those of other relevant studies [31, 144, 145] and suggested a number of vital factors that could affect the success of an adaptive interface. These include spatial stability, accuracy, and frequency of adaptation, frequency of interaction with the interface, and the complexity of the tasks and of the interface itself.

3.6 Adaptation on Education Systems

There is a need for Web-based education systems to replace classrooms, where classrooms and platforms are independent; the main problem with these systems today is that they consist of a network of static hypertext pages [147], which means the demand for interaction will increase. At the same time, adaptation is providing the usage of one type of content to all users, regardless of differences in knowledge, skills, preferences, background, and abilities [130]. Therefore, adaptation becomes important if such systems aim to serve users with diverse needs [147]. In addition, people have different preferences for one or more learning styles. Those who prefer two or more are described as multimodal learners. According to Silverman, there is a theory that describes a brain as a specialised part with a different mode of thinking: the left part is for linguistic, analytical, and sequential tasks and the right part is for artistic, gestalt, and creative tasks [148]. This means a verity of thinking to any particular problem, meaning there are different ways of learning.

Adaptation is intended to be a bridge for any barriers to online learning, which means any poor communication between the machine and the learner adaptation may raise; however, adaptation techniques differ and it is not always clear which to use to solve a particular problem [149]. The main problems in producing adaptive Web-based learning systems [124] are that users have different knowledge and that the knowledge held by any particular user can change quickly. Thus, the same page on a system may change the level of adaptation, but users my novice users and boring for advanced learners. Therefore, modern Web-based education systems use different types of adaptation techniques [124], including adaptive presentation and adaptive navigation. Adaptive presentation techniques often adapt the content of the page to user knowledge and to the user model [147]. Systems implemented using this technique are [130]. Many current Intelligent Tutoring Systems (ITSs) employ active sequencing. Important components of ITSs are problem-solving support technologies, of which there are three types that can help learners: intelligent analysis of learner's solutions, interactive problem-solving support, and example-based problem solving [130]. The intelligent analysis of student solutions deals with the learner's final answer or problem. Interactive problem-solving support helps the learner at each step by providing intelligent help, while example-based problem solving helps the learner by providing examples of similar problems that have been solved earlier [147].

3.7 Personalisation

The main question being raised is *what is personalisation*? Personalisation is often defined as online shopping or e-commerce; for example, Rich stated that it is targeted at fulfilling a special customer or user requirement [150]. Deitel et al. define personalisation as using information from tracking mining and data analysis to customise a person's interaction with a company's product, services, website, and employees [151]. Clearly, most definitions defined personalisation as a relation (person and system) between a person's need and demand to attain a certain goal with efficiency on time and easy task. It involves a systematic process of collecting data, then classifying and analysing these data to display a desire with desired user intervention. Personalisation starts after the user is identified through login. This could be a process context by the system via user profile or in the context of an electronic shopping customer file [152]. Customer profiles are cultivated by historically sorting 1-Interaction with the website, 2-purchasing transaction or direct asking, 3- Preferences, 4- Ratings, or 5- recording contextual information (time, date, place) [152].

Research suggests that content and interfaces need to provide easy access to the functions that subjects actually use [31]. Furthermore, users tend to use different functions and styles [133], even when performing the same tasks [153]. Thus, “there is no way to organize features in a way that makes essential functionality convenient for everyone” [133]. This suggests the need to personalise GUIs and their content for each individual user [31] and to increase personalisation in many areas of interactive software [154]. Therefore, researchers have sought to improve the usability of interfaces by adapting them to users’ needs and by tailoring interfaces and systems to the way people naturally work and live [122]. However, many questions arise in relation to personalisation, such as: Do we need personalisation? Are there any drawbacks to the personalising of systems?

Personalisation [155] refers to the automatic adjustment of information content, structure, and presentation to meet the individual needs of users. In other words, personalisation helps to present the right information to the right people [134]. The considerable benefits of personalisation include reduced information overload, while in e-commerce it helps to promote customer loyalty by establishing a one-to-one relationship, increasing both user satisfaction and sales by providing products and services tailored to each individual customer [135, 155]. Information overload on the Web often requires filtering mechanisms [125]. Generally, applications that provide a rich functionality usually make systems too complex for some users, while systems that provide a narrower range of functionality are at risk of losing the user’s motivation. It is often considered that the solution to these problems is personalisation [156]. Furthermore, [19] personalisation helps as user interfaces become more common; many Web users are often less experienced, the number of tasks that users need to complete are continuously increasing, the amount of information available to users is also increasing, and users often have limited time. Currently, even search engines may often need to be personalised to allow rapid navigation to very large numbers of products of such variety that it would not be possible to fit all of the material in a printed catalogue [125].

Today, most e-commerce sites welcome personalisation. E-commerce websites are increasingly introducing personalised features to build relationships with customers and increase the number of purchases made by each customer [19]. Surprisingly, price is not considered to be one of the top three factors in creating customer loyalty [135], whereas personalisation is one of the factors that make a customer feel at home. There are many popular personalised websites which help users to manage and personalise their views. The most popular websites are: Amazon.com, iGoogle, My Yahoo, and MyNetscape. For instance, Amazon.com is estimated to use at least 23 different types of personalisation, basing product recommendations on user purchasing history [134] and tracking users' navigation and selection history to produce the "Page that you made". Another example of a commercial site that uses personalisation is Yahoo, which allows users to personalise both the content and presentation of the My Yahoo page [134]. My Yahoo was the first site on the Web to use personalisation on a large scale [157]. Manber, Patel, and Robison [158] indicate that the Yahoo site applies personalisation in three areas: My Yahoo, Yahoo Companion, and Yahoo Search. In My Yahoo, users are able to set up the page to contain information of interest to them and then use this rather than the main entry page to access My Yahoo. The user can choose information of interest from the hundreds of modules that Yahoo provides, such as news, weather, and sports. However, such personalisation has drawbacks. According to [158], the discussion of personalisation often raises questions about privacy and security. The threat to the privacy of users is the main drawback when personalisation is applied to software. Many websites collect personal information about users (sometimes without their consent), track their behaviour, and build profiles [135].

3.8 Customisation Approach

Customisation is often considered to play a key role for organisations that aim to stay ahead of the competition in a global marketplace [159]. Customisation offers users the ability to configure an interface, information, or services manually according to their preferences (for example, consider the my.yahoo.com website) [130]. The aims of customisation are to satisfy highly heterogeneous customer needs at low cost [160], to present customers with very specific products unique to them [161], and to encourage repeat transactions [127]. There are several different ways to achieve this, such as loyalty programmes (special bonuses), the application of proprietary standards for products and services, and the use of customisation. Many companies have attempted to engage customers on a more personal level through the processes of mass customisation [160]. However, several research studies have been carried out to determine when and what users can customise. For instance, one study [162] measured the way that different types of customisation affect performance in terms of time taken to complete tasks. Three customisation strategies were considered: ‘up front’, ‘as you go’ and ‘no customisation’. In the first, users added all interface features before starting the given task, while in the ‘as you go’ strategy, they customised the relevant interface features of a function at the time that they were required to complete a particular task. In the final case, users did not customise at all [163] but made use of the full interface. The results of this study indicate that the ‘up front’ strategy was always faster than ‘as you go’ and customisation was generally worthwhile, particularly for novice users. Thus, the study demonstrated that the most efficient time to customise is before starting a task. Another study compared an adaptable interface to the Smart Menus adaptive interface of MSWord. The results indicate that users usually customised very little, because customisation facilities are often complex and therefore require time, both for learning and for doing the customisation itself [164]. A survey by Fletcher [165] found that 68% of Web users who personalised an e-commerce site had made a purchase online, compared to 28% who had not used personalisation features. However, only 8 presents of the 300 UK websites in Fletcher's survey offered personalisation options to configure the site. Less than one-quarter of the sites in the survey offered registration and only 9% made it compulsory. According to [133], most users fail to customise effectively and, therefore, the challenge is to create improved methods for users to direct interfaces, rearrange functionality, and recover from inappropriate adaptations.

3.9 Online Information Systems

The goal of online information systems is to provide reference access to information. The problems with such systems [124] include an inability to satisfy users' needs and the fact that users will have different goals in accessing them. They will also often have no time to browse all the information to find the information they are looking for. When a large amount of information is available, users can be divided into those who have a clear goal, so do not need any help with navigation, and novice users who will need such help. Examples of online information systems are Hypadapter [166], HYPERCASE [167].

3.10 Information Retrieval and Recommender Systems

Google.com provides one of the best known information retrieval (IR) systems, a new service called Personalised Home, which allows users to retrieve personalised information by customising the home page. Users can view the home page they have made via a browser on a PC, on a mobile phone, or on a PDA [168]. The main difference between the IR and recommender systems are the criteria utilised in the latter [169]. Among the techniques used to make recommendations and suggestions to users are collaborative [170], content-based [171], demographic [170], utility-based

[170] and knowledge-based recommendation [172]. Recommender systems [138, 173, 174] are now utilised in e-commerce sites, such as Amazon.com [173].

3.11 Online Help Systems

An online help system is similar to an online information system. The main difference between them is that online help systems are not independent but attached to an application system. Another is that the hyperspace in online help systems is smaller than in online information systems. They share with online help systems the problem of serving different information to different users [124]. Examples of online help systems are EPIAIM[9] [175], HyPLAN[10] [176], Lisp-Critic[11] [177].

3.12 Customisation Techniques

Customisation was originally seen mainly as a new paradigm for marketing [178]. There are four approaches as identified by Gilmore and Pine [179] to product customisation: collaborative, adaptive, cosmetic, and transparent customisation. The collaborative customisation approach involves companies helping users to identify their individual needs and then offering them products which correspond to those needs. With the adaptive customisation approach, the software is designed so that customers can modify it in the absence of any direct interaction with the software company. The collaborative and adaptive customisation approaches therefore both involve users in the co-design of the software product. However, cosmetic customisation is mainly concerned with representation and display, rather than the functionality of the software. The transparent customisation approach provides tailored

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[9] EPIAIM is a knowledge-based system developed to support health care professionals in epidemiological data analysis (Adaptive System) [147].
[10] HyPLAN is a context-Sensitive Hypermedia Help System for users of the spreadsheet Excel on Macintosh computers [148].
[11] Lisp-Critic is a prototype of an intelligent support system to enhance incremental learning of a system and support learning strategies, such as learning on demand [149].

software products without the users being aware that those products have been modified.

Recently, several alternative approaches have been proposed for websites. Among these is the modular product approach [158], which is not very different from other more general product platform approaches for the effective generation of product variants [180]. Other approaches proposed are the generation of recommendations based on user preferences or user similarity compared to earlier users [156]. Search agents may also help customers find the products they really need [181], while the creation of several simultaneous product versions designed for different target groups may assist customisation [180]. According to [160], online sites can be customised to users' needs and preferences. For instance, each customer can be guided through the purchase process and only the products of interest will be displayed. These sites offer special deals for users and provide testimonials to those who want to read what other customers have said about the product.

3.13 Customisation of Non-Software Products

Nowadays, large companies customise such products as gadgets, coffee, cars, shoes, computers, and many others. As an example, General Motors has developed a concept called autonomy [161], which enables consumers to customise their cars.

Nike offers customised footwear by allowing customers to choose up to 12 different components for each shoe, and thousands of colour combinations are possible [182]. Customers are allowed to design a personalised name or slogan, and for a small cost, even the left and right shoe sizes can differ. All of these customizations add to the retail price. Customisation offers good value and low cost with vans.com, which allows customers to create a personalised version of the company's slip-ons at a relatively low cost. The Timberland.com website has a page called "Build Your Own", which allows customers to specify the features of their boots. Polo Ralph Lauren has also introduced the option of customising its products. Thus, customisation offers an opportunity for users to contribute to the design of their own products and ensure that no one else will have exactly the same customised product with their prices.

Additionally, some companies have begun to customise the entire marketing process, transforming the practice of marketing from seller-centric to buyer-centric [183]. This approach, called customisation, refers to both the product and the market. It involves more than just mass customisation and is a business strategy to recast a company's marketing and customer interfaces to make them buyer-centric. Another company, garden.com, allows customers to design a garden to their own preferences [184], while Dell has established custom websites for their business customers, whose employees can order computer configurations that have been approved by those companies [160].

3.14 Empirical Studies of Adaptable Approaches

Studies with adaptability approaches have been conducted on the technique. Page et al. examined the amount and type of customisation and found that 92% of participants customised their software with WordPerfect 6.0 [185]. However, the results showed that customisation had become popular to users. Mackay conducted two other studies with 51 participants, examining the reasons for customisation and identifying the factors that affected it [163]. Results found that users might be prevented from customising because of many factors, including lack of knowledge, while factors encouraging them to customise included social pressure, software upgrading, and external factors (e.g., job and excess free time). Additionally, it was found that 78% of participants had done some sort of customisation. In another experiment, Mackay attempted to distinguish between users who customised and those who did not [186]. From another two groups of users, results showed highly-skilled software engineers and translators. The two groups were separated and worked with two different types of customisable software. The first group was not able to determine whether their customisations were useful to other users, while the second group created customisations that were tailored to the needs of others. Another study [187] showed that customisation could be affected by the skills of users, who were classified as workers, tinkers, and programmers. They found that workers did not expect to customise, that programmers did expect to customise, and that tinkers lay between the other two groups.

McGrenere et al. stated that two different strategies were used in customising their interface and they were called 'up front' ' and 'as you go' [162]. Results showed that 32% of participants customised before the task (up front), while the remaining 68% customised in an incremental manner (as you go). It was also found that 63% of participants chose to add all features, while 37% added only the frequently used features. Moreover, no users removed the added features, even if at some point they were no longer needed.

Other studies promoted the idea of multilayer interfaces, with users being able to switch between interfaces [157, 188]. The design of multiple layers required more careful design because each layer had to meet users' expectations and needs. Such layered interfaces have been heavily evaluated and used. One example is a study comparing multi-layered approaches to a control interface, which found that layered interfaces were better than full interfaces alone in terms finding ability, while subjects were more aware of advanced features in the full interface [189]. This study showed that layered interfaces can increase performance as compared to full interfaces, while marked layered ones showed little benefit.

3.15 The Mixed-Initiative Approach

Fisher pointed out in 1993 the need for a system combining the advantages of adaptability and adaptivity [190]. However, Horvitz stated to combine both techniques and give it a name of mixed-initiative systems where were defined in 1999 [191]. Little attention has been paid to interfaces that combine adaptive and adaptable elements. Bunt stated that, adaptive systems and mixed-initiative are nearly similar to some extent [192]. There are some exceptions, including the FlexExcel project[12] [193-195]; nevertheless, the mixed-initiative approach is common and one use of it is in the dialogue systems, which allow both users and the system to initiate the dialogue. As [192] has pointed out, it is also common in systems that aim to identify users' goals to assist them in completing his task more efficiently (e.g. , [196, 197]).

Research on mixed-initiative systems has been discussed according to the techniques and task performed [25]. According to [162], system decision making should be considered for users' characteristics and tasks, depending on the system choosing the right approach for each user. The ability of understanding user's need is the user's ability to customise effectively, with right action. Otherwise, the system should be useless. When the adaptation takes place and applies customisation, it helps to know more about the user's preferences. Conversely, when the customisation system applies adaptation, users are able to customise more efficiently [162]. Some systems have adopted the mixed-initiative approach to the content of the system, an example being the Adaptive Education Hypermedia prototype, which produced a system called INSPIRE[13] [198] that was separated into two parts, one being adaptive

[12] The FlexExcel project is an extension project to the Excel software package that integrates adaptability and adaptivity by providing adaptive suggestions for defining new menu entries or shortcuts [165].

[13] INSPIRE is an instructional design, adaptivity and adaptability features of Adaptive Educational Hypermedia (AEH) system named (INtellignt System for Personalised Instruction in a Remote Environment) [170].

and the other adaptable. Others have applied the mixed-initiative approach to the interface rather than the content of the system. For example, a system was introduced [193] to provide an environment that adapted the Excel user interface to users and their current tasks. The results suggest that the adaptive component provided potentially beneficial adaptations to users and motivated them to adopt the interface. Another study [162] examined the way that the characteristics of the users' tasks and customisation behaviour affected their performance on those tasks. The results indicated that users may not always be able to customise efficiently and that customisation is beneficial in reducing the time taken by users to complete tasks. In this way, the potential for adaptive support to help users to overcome their difficulties was demonstrated.

3.16 Categories of Mixed-Initiative Approach

Bunt stated that there are four types of mixed-initiative interactions: conversational interaction, user-controlled adaptation, users overriding adaptive support, and users providing relevant feedback[192]. Conversational interaction is common in dialogue systems (e.g. L2Tutor [114] and SMARTedit [115]), where taking the initiative is important to lead the topic. In user-controlled adaptation, users can manipulate the algorithm directly (e.g. Lumiere Project [199]). The user provides relevant feedback is that system responsible for responding [200] and user override the support is provided by the system [201].

3.17 Empirical Studies of Mixed-Initiative Approaches

Some software uses methods such as the FlexExcel system, which provides adaptive support for customisation in Excel and integrates adaptability and adaptivity by providing suggestions to users [202]. This example was given to determine which areas may benefit from adaptation. The suggestions and critique feature use a rule-based frequency approach; also, there is a new suggestion: the system notifies the user by sound and with a “tip” icon that blinks three times. FlexExcel was evaluated in an experiment with 13 participants, some of whom were found to have difficulties in initiating the customisation. Another example of a mixed-initiative approach is the Programming by Example system for the HyperCard environment called Eager [203]. This monitors usage and, when a pattern is detected, a pop-up icon notifies the user that Eager is ready to recommend. When Eager detects a repetitive activity, it highlights menus and objects on the screen. While the user continues to perform the task, Eager anticipates each next action by turning menu items, buttons, and text selections to green. Once the user is confident that Eager knows how to perform the task correctly, he or she clicks on the Eager icon and the task will be completed automatically. The study found that first-time users were generally able to understand Eager without instruction, but users were uncomfortable with giving up control.

An additional example is a study using adaptive suggestions to reduce the complexity of an adaptive toolbar implemented in MSWord [112]. The system allowed users to add and delete toolbar features. Suggestions were notified by changing the background colour of the toolbar and by using sound.

A multi-layer user interface provides users with suggestions on using either a menu-based interface or a command-line interface [204]. The suggestions are based on the number of user errors and the user’s computer experience. In addition, users are allowed to choose the layer they prefer to use. Conversely, the system makes some layers visible to users based on their editing history. However, there is no evaluation provided in this study.

A mixed-initiative approach was utilised to support interface customisation implemented to reduce the complexity of GUIs [205]. The researchers examined two interfaces: a normal MSWord interface and a feature-reduced version of the same interface containing only features that the user had chosen to add. Their results showed that the mixed-initiative approach was preferred to a purely adaptable approach. In addition, it was found that that the system's suggestions helped to improve task performance. **Table 4** compares the adaptive and adaptable approaches.

Table 4: Comparison between adaptivity and adaptability adopted from[11]

Characteristics	Adaptive	Adaptable
Driven by	Systemised [31]	User driven [31]
Control	Systemised in controlled [31, 133]	User in controlled [31, 133]
Adaptivity based on	Information and tracking user behaviour [198]	The user's stated Preferences [163]
Changes & preferences	Change over time based on user browsing patterns, purchases, and participation [44]	Do not change unless users update their information [25]
Users preferences	Required [154]	Not required [154]
User experience	Not required [135, 158]	Required [158, 206]
Users used	Hard to understand [207]	Hard to use [163]
Time of adapting	Not required from users [31]	Requires time, both for learning and for doing the customisation [164]
Users' interests	Users are not familiar with computer-modified and intelligent results; instead they are familiar with static presentation [158]	Users usually customise very little [164] because they do not have time or interest [163]
Complexity	Very complex [164]	Powerful and complex [164]
Users' needs	Confusing [164]	Needs help [205]

3.18 Advantages and Disadvantages of Personalisation

Personalisation has a strong relation to adaptations. Therefore, the techniques introduced in **Table 4** are in the heart of each characteristic of each model of adaptive, adaptable, and mixed-initiative; each have many advantages and disadvantages. For instance, adaptive systems have advantages for users, such as saving time in locating relevant information, ease of online transaction, and ability to connect quickly with the right resources and people [68]. Additionally, adaptation provides some unique benefits to an organisation, such as real-time data regarding member preferences, ability to classify member data to identify interests in various categories, ability to deliver targeted content, and recommendations to individuals and organisations to help plan programmes, products, and services that meet the needs of members, regardless of the opposition to security issues. Conversely, there are some disadvantages to users and organisations [68]. Adaptive approaches provide less control to users because they might miss content, and there might also be privacy concerns [68]. The disadvantages to organisations are that expectations may be raised about adaptive conditions for solving more basic Web usability problems and that personalisation and customisation costs will vary and will require resources [68].

Manber, Patel, and Robison [158] were concerned that high-skill personalisation. Usability is the most difficult technical issue at this point. They used predictability as an example to demonstrate the weakness of personalisation. They also believed that scalability must be built into any Web personalisation because people expect the software to interact quickly with users. However, they point out that My Yahoo users usually do not customise [162, 163], but accept the facilities offered on the default personal page (in fact, this raises the need for adaptation). They suggest that a user fails to customise because the default page was bad, the customisation tools are difficult to use, and most people do not need complex personalisation. Additionally, they indicate that users are not used to unexpected, surprising, and intelligent results, but are used to static presentations. In general, they argue, users do not understand customisation; therefore, it is very important to present customisation in an intuitive, rather than surprising, way.

Table 5: Advantages and disadvantages of adaptive and adaptable approaches

	Adaptive	Adaptable
Advantages	▪ Reduced complexity of software, control, and help to avoid overloading or “underloading” the user [157]. ▪ Time-savings in locating relevant information [68]. ▪ Increased speed and accuracy [69, 157]. ▪ Enhanced user learning process, decreased search and navigation time, and reduced risk of being lost in hyperspace [69]. ▪ Ability to connect with the right resources quickly; provision of products & services that meet needs [68].	▪ Time savings in locating relevant information [68]. ▪ Ease of doing business online, and ability to connect with the right resources and people quickly [68]. ▪ Customisation facilities are often powerful [164],
Disadvantages	▪ Lack of control over the process, lack of transparency, and lack of predictability [162]. ▪ User registration required; profile required to be built; collecting personal data; and complexity of implementation [135]. ▪ Data and privacy protection problems [51]. ▪ User is observed by the system and can be distracted from the task [51]. ▪ Complexity of implementation and difficulties in evaluating adaptive systems [157].	▪ Users usually customise very little [164]. ▪ Customisation complex and requires time for both learning and customising [164]. ▪ Users lack interest and time; difficulty in modifying settings [163].

The main advantages and disadvantages of both adaptive and adaptable systems are listed in **Table 5**, which describes the most important points of both systems. Mackey [163] studied the customisation activity of 51 staff members using a UNIX software environment and found that when users faced a problem, they could either change their behaviour or customise the software. From the user’s perspective, the second choice took more time but created fewer risks. The study also showed that there were many triggers of and barriers to customisation, categorised as external events, social pressures, software changes, and internal factors. Examples of factors triggering people to customise were job changes, office moves, going on trips, breakdowns, and upgrading, and the most common barriers to customising were lack of time and interest, and difficulty in modifying settings. Mackey found a solution to shortage of time by allowing users to share their customisations.

Adaptation offers interaction by increasing speed and accuracy, enhancing the user learning process, reducing search and navigation time, limiting the risk of being lost in hyperspace—which often causes systems to lose users—and helping to improve user satisfaction [208], [69]. The effects of different kinds of adaptive systems [155] could differ according to the area of application and the perspective [124]. However, there is one drawback to applying adaptation to any system: The interface is less stable for the user. This results in confusion, especially for unfamiliar users. From the implementation point of view, adaptation is difficult to achieve because adaptive systems are complex and expensive [69].

3.19 Empirical Comparisons of Personalised Approaches

Many researchers believe that selection time is reduced by prioritising frequently selected items for choice. Research by Smeaton stated this finding in a controlled experiment with 26 subjects who were asked to search for names in a telephone directory accessible through a hierarchy of menus; this was tested against a static system [149]. Subjects performed faster with the adaptive system, which were preferred by 69% of them. In addition, results showed that the adaptive system reduced the search paths for repeated names, reduced time per selection by 35%, and reduced errors per menu by 40%. Trevellyan and Browne[209]replicated this experiment with a larger number of trials because they believed that subjects would eventually become familiar with the static menu and memorise the required sequence of keypresses. They found that the adaptive system was effective and that after using it for a long period of time, users did begin to perform better with the static interface. Another study compared an adaptive menu with a static one. In a controlled experiment, 63 subjects were requested randomly to complete 24 tasks using both menus. The results showed that the static menu was faster than the adaptive menu on the first group of tasks, but that there was no difference in the second group of tasks between the static and dynamic menus because subjects in both groups were able to increase their performance significantly. Eighty-one present of the subjects preferred the static to the adaptive menu [159]. In another example, a static interface was compared to three adaptive alternatives as follows: (1) split interface, with which important functions were copied into an extra toolbar; (2) moving interface, with which important functions were moved into a toolbar, and (3) visual pop-out interface, with which important functions were moved and made visually prominent. Two experiments were conducted. The first had 26 participants and investigated the impact of the different interfaces under two adaptive algorithms (frequency vs. recency based). The results showed little difference between the interfaces for the cognitively more-complex task, while on the less-complex one, the split and moving adaptive interfaces were faster than the static interface. Furthermore, in terms of satisfaction, perceived benefit, and perceived cost, the split and moving adaptive interfaces were found most beneficial and least costly, and were preferred in the more-complex task. The visual pop-out interfaces were found distracting. In the less-complex task, there was less support for the adaptive interfaces. The second experiment was conducted with 8 participants and compared adaptation accuracy (70% vs. 30%). The results showed that user performance worsened as the adaptive algorithm's accuracy decreased. Another between-subjects study with 40 participants examined an adaptive approach to command line usage [130]. It compared (1) a command-line interface, (2) a menu-based interface, (3) a hybrid interface, for which participants had access to both the menus and the command line, and (4) an adaptive interface, for which the system moved users from the menus to the command line. It was found that the adaptive interface was significantly faster than the non-adaptive, hybrid approach. Another study compared the performance of adaptive and static menus [124]. More recently, a study examined a new adaptive technique called ephemeral adaptation. Ephemeral menus present predicted items immediately, while remaining items gradually fade in [123]. These new techniques were examined with static and highlighted adaptive menus. The results showed that ephemeral menus were faster and preferred over the static control condition when adaptive accuracy was high, and no slower when adaptive accuracy was low. In addition, ephemeral menus were faster than highlighted adaptive menus, while both were preferred to static menus.

3.20 Static vs. Dynamic

Experiments have compared static and dynamic applications and interfaces. An example is an experiment [31] that was carried out with 27 subjects to compare the performance (speed and error rate) of static, adaptive, and adaptable menus. In that experiment, each menu was implemented separately. It was found that the static menus were faster than the adaptive ones, but not faster than the adaptable menus. In that experiment, the adaptable menus were faster than the adaptive ones, except when subjects used adaptable menus first. It was found that 55% preferred the adaptable menus, 30% the adaptive menus, and only 15% the static ones. Such experiments indicate that a strong majority of users wanted a personalised interface. It was also found that the adaptive menus were slower than the adaptable ones, except when subjects used the adaptable menu first [31]. This study demonstrated some other important issues. First, ease of use is not sufficient in customisation because some users did not recognise the value of customisation; therefore, the authors suggest that users should be provided with examples. In the same study, it was suggested that providing users with control will lead to a better perceived performance and higher overall satisfaction.

3.21 Adaptive vs. Adaptable

In addition to the comparison between static and dynamic techniques, research studies have compared adaptable and adaptive techniques. Direct comparisons of adaptive and adaptable approaches have also had conflicting results. For example, a 6-week field study with 20 participants evaluated two interfaces combined with adaptive menus in the commercial word processor MSWord 2000. These were a personalised interface containing desired features only and a default interface with all the features. During the first four weeks of the study, participants used the adaptable interface, and then used the adaptive interface for the remaining time. It was found that 65% of them preferred the adaptable interface, 15% favoured the adaptive interface, and the remaining 20% chose the MSWord 2000 interface. However, according to [133], there were two potentially confusing variables. First, MSWord 2000 and the proposed interfaces had very different designs, which may have differed in their usability. Second, all participants completed the adaptive condition after the adaptable condition. In another study, McGrenere et al. carried out a controlled laboratory experiment with 27 participants to compare the efficiency of three of the Sears and Shneiderman [125] split menus. The first of these was a static split menu, the second an adaptable split menu (with a top half that was adaptable by the user), and the third an adaptive split menu (with a system that dynamically assigned the top half based on frequency and recency of selection). The experiments found no interactive effect between order and menu. Conversely, the comparison was complicated [133] because performance depended on menu order and subjects were exposed to the three conditions; however, when they were not presented with the adaptable interface, they were significantly faster with the adaptive or static ones. The findings were that split static menus were significantly faster than adaptive menus. The adaptable menu was faster than the adaptive menu when participants were guided by example, because they were able to understand the value of customisation. In addition, results showed that under such circumstances, there was no significant difference between the adaptable and static menus. Nevertheless, 55% of subjects preferred the adaptable menu, 30% the adaptive and 15% the static. In another laboratory experiment with 18 participants, Jameson and Schwarzkopf directly compared automatic recommendations that controlled the updating of suggestions and a condition for which no recommendations were available. The comparison concerned content rather than the GUI. In the automatic recommendation (i.e., adaptive) system, the updating was performed automatically by the system, but in the (adaptable) system (using controlled updating of recommendations), it was done by users, and in the third (static) system, no recommendations were provided to users nor did the system change during usage. Jameson and Schwarzkopf found no differences in performance score among the three conditions.

3.22 Mixed-initiative vs. Adaptable

Most studies in the field of personalisation have been limited to the differences and similarities among the static, adaptive, and adaptable approaches. Consequently, there has been a small amount of research into mixed-initiative interfaces. Very few references were found in the literature to direct comparisons of a mixed-initiative system with either an adaptive or an adaptable alternative. One of these rare studies compared a mixed-initiative toolbar with an adaptable one. Specifically, it compared an adaptive bar (mixed-initiative system) with the built-in toolbar present in MS Word (adaptable system) [112]. It was found that the mixed-initiative system significantly improved performance in one of two experimental tasks. In another study, Burnt et al. [192] designed and implemented the Mixed-Initiative Customisation Assistance (MICA) system, which provided subjects with the ability to customise their interfaces according to their needs, while also providing them with system-controlled adaptive support. They found that users preferred mixed-initiative support and that the MICA system's recommendations improved time on tasks and decreased customisation time.

3.23 Critical Assessment

Many researchers have attempted to reduce the complexity of GUIs and content by using adaptive or adaptable approaches, each of which has its unique challenges. For example, lack of control, predictability, transparency, privacy, and trust are the main issues in adaptive interfaces, whereas in the adaptable approach to customisation, time, difficulty, and lack of interest are the main difficulties [163]. Recently, several researchers have attempted to evaluate the effects of these drawbacks. For example, they evaluated personalisation approaches using different levels of controllability [112, 164, 205]. In addition, several studies have been conducted in an attempt to overcome the limitations of these approaches. For example, some researchers have suggested multiple interfaces as a solution [210], while others have attempted to use both approaches in such a way that one could be used to support the other [162, 205, 211]. Some researchers have suggested allowing users to overrule any adaptation actions, but others have proposed recommending adaptations to users and leaving them to make the final decision to accept or reject these suggestions [195]. However, little research has been done on interfaces and content that combine both adaptive and adaptable approaches (i.e. mixed-initiative). Furthermore, an examination of the current research into adaptive, adaptable, and mixed-initiative approaches indicates that researchers seem to have neglected other channels, such as sound and haptic. An equally small amount of research has examined the factors that make a personalisation approach successful at one time and unsuccessful at another [143]. This includes studies examining the effect of screen size in adaptive and adaptable approaches [27, 212]. Finally, very little work has been done to evaluate directly and empirically the adaptive, adaptable, and mixed-initiative approaches to both GUIs and content. Therefore, the research interested in enhancing the interface design process, human computer interaction to enhance and encourage vocabulary learning to ease memorable vocabularies.

Chapter 4: Integrating theory and practical implementation

Integrating theory, research, and practice is an issue related to achievements motivation, as discussed by Stripek [213]. The initial structure in this chapter explored theories of learning and carried out the investigation of adaptation in learning; therefore, that section of this chapter has been divided in two main sections. The first section involves theories related to learning, the most effective being those that motivated users to learn vocabularies. The second is the practical section, which includes pilot study analysis and presents research hypotheses and sub-hypotheses that guide users to answer all questions posed by this research. The pilot study was analysed to examine the validity and precision of standardised learning times and recall times for complex vocabulary. The main goal of this project is to deal with vocabularies, and enhance learning these vocabularies in terms categorised them in three categories as it has been collected and surveyed before starting the experiment. Easy word which used believed easy and measured wised during the experiment. Moderate word is the word that students believed it not been easy and had time to memorised. Difficult word which is students believed that it is extremely difficult to understand and timely wise showed longer time frame to memorise. **Note**: during this thesis word and vocabulary was interchange, and referred to one single word, during this thesis word and vocabulary was interchange, and referred to on single word.

4.1 Introduction

This section addresses the second part of question one, stated in Chapter 1, by considering both the theory and practice of learning. Learning is a process which involves principles and theories [214]. According to Ormrod, principles inform us about factors that are important for learning, whereas theories inform us of why these factors are important [215]. According to Biggs (2003), learning has been the subject of research by psychologists for the last century, although little has happened to improve the quality of teaching. He states that psychologists have been more interested in trying to develop theories for learning than studying the contexts in which people learn, such as schools and universities [216]. In fact, the starting point is to discuss these theories and their effects on learning and the learner. To produce a quality product, it is necessary to look at different ways to produce effective learning based on student abilities. Not all students are talented, so the interface should accommodate the student's ability to learn. The contributing system related to the educational system implies a high level of detailed information. Several systems were developed for educational purposes. The user model was based on existing knowledge, and adaption occurred at two levels: the content level (adaptive presentation) and the link level (adaptive navigation)[217].

4.2 Aims

The aim of this study is to investigate the theoretical aspect of learning by incorporating learning vocabulary into four interaction interfaces. These platforms are static, adaptable, adaptive, and mixed-initiative interaction in terms of usability and language learnability. The evaluation of usability includes three genres in term of effectiveness, efficiency, and user satisfaction. In fact, such incorporation is aimed at measuring the usability of these systems as well as the user's attitudes and knowledge regarding different tasks.

4.3 Objectives

Pursuing the previously discussed aims begins with the theoretical aspect and then the evidential aspect of experimental test. The three different experimental platforms developed in online learning websites and a set of vocabulary learning was completed. The online learning platform consisted of three sub-platforms: adaptable, adaptive, and mixed-initiative. The main contribution to Web-based learning is adapting each approach to learners and then studies the effect of control to user knowledge to each approach, regardless of how the Web content is delivered. This can effectively reduce the gap between what they need and what exists on the Web. To fulfil our goals, precise measurements are taken for every item and condition by timing the completion of tasks and quantifying errors under each condition. The second objective is to measure the collection of user opinions by using the SUS scale with *agree* or *disagree* for each condition and then calculating the percentage of these results. The third objective is to measure user satisfaction under each condition and obtaining the subjects' opinions; two questions need to be added to measure user achievement in vocabulary learning.

4.4 Theories of Learning

According to Deubel, incorporating a variety of learning theories is needed when trying to integrate technology in teaching and learning [218]. A study conducted by Ritchie (1997) in an attempt to integrate technology and the constructive theory of learning in a classroom has shown difficulties in terms of gaining knowledge and skills [219]. Conversely, after combining three theories of learning, such as behaviourism, cognitivism and constructivism, the result has shown better learning as compared to their previous attempts at integrating only one theory of learning into computer technology [214]. According to Jonassen (2006), there are more than 100 theories that may be used to describe learning [220], and each of these theories has its own elements and vocabularies to describe processes that are believed to be occurring within the learner. Three learning theories (behaviourism, cognitivism, and constructivism) are frequently discussed by researchers in relation to computers in education. These theories are often applied in the creation of instructional environments [221].

4.4.1 Constructivism (learning theory)

Constructivism is a theory of knowledge which suggests that learners create their own knowledge matching their own experiences, in that sense creating knowledge as they attempt to understand their experiences [222]. This means humans generate knowledge and meaning from their interactions between their experiences and their ideas. Morrison and Lauzon (1993) stated that constructivism can help reconceptualise distance education by using new technologies to alter how distance education is conducted [223]. Jonassen et al. (1995) suggested that constructivism provides the theoretical basis for a unique and exciting distance online learning environment [224]. Constructivism is a theory which provides a psychological/philosophical foundation for learning. Constructivists believe that the personal word is constructed in mind construction them and defines them to related realities. The mind is an instrument of thinking that interprets events, objects, and perspectives rather than seeking to remember and comprehend object knowledge [224].

4.4.2 Behaviourism Theory

Behaviourism is based on a theory of learning perspective; it studies the behaviours of a learner that can be observed and measured because it refers to their action, thinking, and feelings [225]. Researchers believe that the mind is like a "black box" in that its response to a stimulus can be observed quantitatively without any need to investigate or refer to the mental processes that cause that response. Subsequently, positive and negative feedback was used to reinforce behaviour in test subjects. Behaviourism regards learning as a passive process in which knowledge is transmitted from the instructor to the learner [226].

4.4.3 Cognitivism Theory

Cognitivism is a theory of cognition which suggests that all "*mental activity is cognitive and that perception, understanding learning and action are all to be under-*

stood on the model of fact gathering, hypothesis formation, interface making, and problem solving” [227]. Cognitivism is a theory of fostering learning by weaving new information into the existing network of learner knowledge [228].

4.5 Learning and Teaching

On a daily basis, invention and innovation involve searching for the best technologies that can help learners or transfer these technologies for optimal use; this is the nature of human life. Learning is one of the area that positively affected by these two states.

4.5.1 Active and Passive Learning

Active learning involves the environment surrounding learners, allowing them to interact by talking, listening, reading, writing, and reflecting on their own knowledge of course content. Active learning involves activities through problem-solving exercises, simulations, groups of students, and any activities for which students apply what they are learning [229]. Active learning is an approach for which learning is paramount for both learner and teaching methods to influence student activity of learning. However, some researchers disagree and feel that listening to lectures, watching films or television programs, and browsing websites turns students into passive learners [230]. Lambert and Balderstone (2000) define learning as an active process that connects knowledge and meaning; therefore, new ideas, thoughts, and skills are being obtained [231].

Passive learning is a more traditional method, which involves students using a black or white board, taking notes, and following instructions. The instructor is the key to learning, depending on the effect he or she has on the students. Students collect information as a computer memory, without engagement or arguments behind the theory reflect on learning [232]. The way of learning is similar to a radio receiving a signal without any transmissions or interactions. .The success of passive learning cannot be ignored. The fact is, might be preferred by some teachers and students. The efforts behind action of developers, teachers, and managers in education generally needed to help preparing students to be more active and engage themselves learning.

4.6 e-Learning

Chambers has stated:

"*....The biggest growth in the Internet and the area that will prove to be one of the biggest agents of change will be e-Learning...*"

CEO, Cisco Systems [233].

Many researchers have defined online learning in many different forms, depending on the context [234]. The concept of online learning is used to refer to the use of electronic tools in a learning process. However, there has been disagreements regard to the definition because the use of electronic devices, such as the microphone and data projector, is not applicable in its definition and use. Tavangarian and Leypold (2004) suggested the following definition: Online learning and all forms of procedural electronic supported learning and teaching, aims to affect the construction of knowledge with reference to individual experience, practice and knowledge of the learner [235]. Tavangarian and others stated that online learning has reached the golden age of investment ROI (return on investment), where many projects were moved into the centre to optimise the learning process.

The e-efforts in online learning almost equal the e-efforts in e-business; in this case many consulting companies presented online learning to the public as a profitable motive case rather than an optimistic study case [235]. Alternative definitions vary; for instance, GmbH defines online learning as aggregation of all kinds of learning which use the computer for medial support of the learning process [236].

4.6.1 Online learning Environments

According to Dietinger, online learning consists of at least one or more online learning students who try to achieve a specific learning goal; conversely, the content of online learning represents the learning subject, the learning objectives, and the guidelines on how to achieve these objectives. The contents could be multimedia and interactive. The environment works as an interface between the students and their learning objectives and provides different means to achieve the learning goal. The Web browser plays the role of supporting several learning strategies and methods of interaction, communication, and collaboration [237]. Environmental learning may include continual administration, management utilities and interfaces to other systems to support the organisation. There are lists of synonyms to describe online learning, with different variations in its feature-set; for example:

- Computer Managed Instruction System (CMI-System)
- Learning Content Management System (LCMS).
- Learning Management System (LMS)
- Virtual Learning Environment (VLE)
- Web-Based Training System (WBT-System).

4.7 Experimental Approaches

The three experiments described in the following sections were set up with the participation of Arabic learners of intermediate. . Each of the experiments had a distinct language focus, but the results consistently corroborated the hypothesis that changing adaptation methods can facilitate vocabulary achievements in the English language for non-English speakers. At the same time, however, the experiments point to different methods.

4.8 Common Methods of Usability Evaluation

Table 6: Usability Evaluation Methods.

Names & Abbr	Brief Idea	Results	The Sufficiency of Data	Evaluators	Development Time	Reference
System Usability Scale(SUS)	Consists of 10 items, Likert scale simple statements, response 1 to 5. Statements positive and negative, scores from 0–100	Above 70 usable	Overall system "Yes" Usability metrics "No"	Open & Quick and inexpensive	1993	Brooke, 1996 [238]
Goals, Operators, Methods, and Selection (GOMS)	Analytical approach in HCI, break down complex tasks into separate subtasks, predict how long tasks performed with user on the task, then time calculated and summing them all to get final time.	Time records	Drawbacks Usability metrics "No" - Errors and outside influence	Open	1983	Card & Moran & Newell [239]
Keystroke Level (KLM)	A variation of GOMS method, goals broken down to subs then total time and accomplished time allocated to standard time.	Compares Time To standardised	Drawbacks Usability metrics "No" - Errors and outside influence	Open	1983	Card & Moran & Newell [239]
Heuristic Evaluation (HE)	Usability inspection method, multiple described characteristics and evaluated how good or poor the goals are they	Completed Checklist Weighted score	May be too specifically detailed & sometimes vague No computer experience	Expert or 3-5 Quack and inexpensive	1990	Nielsen, 1990 [240]
Cognitive Walkthrough (CW) or Walkthrough	Usability inspection method, Users assigned to specific task(s) or a goal to use the interface. Feedback by speaking aloud about (looking at, thinking, like, dislike)	Direct contact to users & "Yes" and "No"	Subjective to each user & to the specific task.	Open & Quick, easy & System's designers	1995 Wilson & Corlett	Wilson & Corlett (1995) [241]
Software Usability Metric Inventory (SUMI)	User report for user satisfaction of a website program compared to others on related site.	50- item survey to at least 15 users or more	Survey is "Agree" or "Disagree" then "Don't Know" compared to evaluated website.	Open	1995 Wilson & Corlett	Wilson & Corlett (1995) [241]

Table 6: consists of 7 columns, each column has specific goal, starting from the first column of evaluation with its abbreviation. Second column is a brief idea about a method and where is going to be used. The third column is to obtain effective results

as suggested. The fourth column is the way of data obtained. The fifth column is evaluation technique. The sixth column is time of discovery and the last column is the reference of the method. These methods were available for evaluating the usability of websites and other methods of human-computer interaction, as shown in **Table 6**. Determining which one to use depends on the advantages and disadvantages of each approach as well as the capabilities of each. The research found that a simple way to measure a website's perceived usability is to apply the SUS. This scale is a ten-item statement; all are Likert scales (see page 224 for more details). Two items have been added to measure learning achievements. The subject gives a response from 1 (strongly disagree) to 5 (strongly agree). Five questions are positive and the others are negative. The score changes from 0 to 100 and, generally, a score above 70 is considered usable [238]. Some researchers have examined the validity of the SUS; reliability was high with an alpha of 0.91 from all SUS selected (Bangor, Kortum, and Miller) [242, 243]. The SUS yields a single number representing a composite measure of overall usability of the system [238].

4.9 The SUS

The SUS is a simple 10-item usability scale written by John Brooke, which seeks the subjective opinion from a user regarding a particular system. It can be used by students to compare learnability between two systems, one static and one personalised, to enhance learning acquisition. These 10 items are more likely to cover usability. Brook stated that

There is a need of broad general measures which is can be used to compare usability across a range of contest. In addition, there is a need for "quick and dirty" methods to allow low cost assessment of usability in industrial systems evaluation [238]

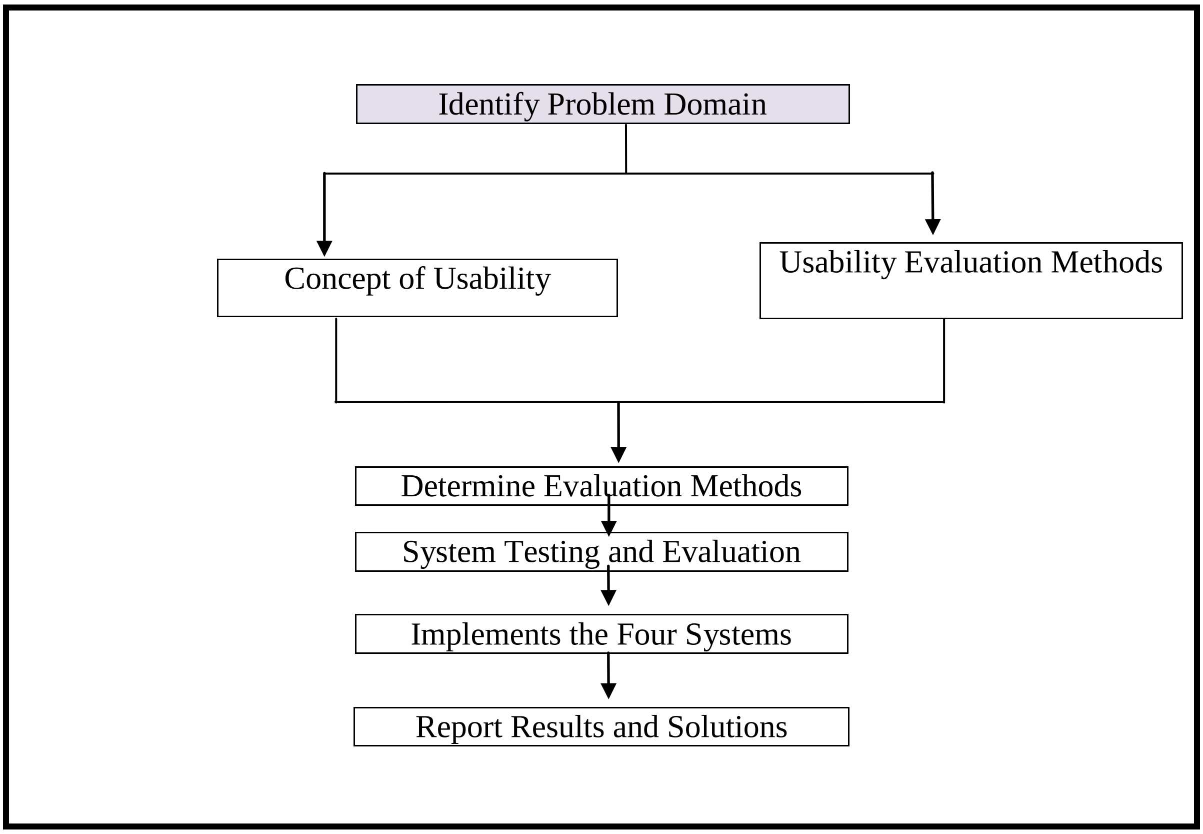

Figure 4: Overall System Usability Structure

The SUS yields a composite measure of the overall usability of any system being studied.

Nielson performed a meta-analysis of various human-computer interaction studies, which collected both user performance data and subjective usability data, such as the SUS. The study concluded that, user performance was measured by time of task and number of errors made [244]. Others concluded the studies by that the subjective data had been collected and, measured based on objective measure or recorder videos [245]. There is a positive association between the three systems and the task. Relying on the previous studies in HCI to complete an effective research, both the objective performance measure and the subjective assessment measure, which is covered by the SUS, must be obtained and analysed. The SUS has uses, provided in a subjective assessment of tasks, which rely on reliable and low-cost of overall usability in terms of single measures of the system; authors of these questionnaires do not intend to act for the single measure of usability itself [246]. This case study expanded to include the study's aim to measure the usability (efficiency, effectiveness, and user satisfaction) as a single measure.

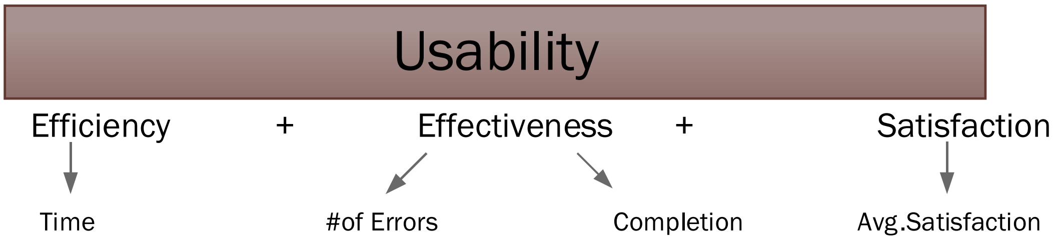

Figure 5: Quantitative Model of Usability from Jeff Sauro

4.10 Methods of Expansion

The methods for evaluating and empirically testing the usability of the three systems were developed by combining elements of the techniques described in **Table 6.** The method consisted of testing DVs of usability metrics, conducting a usability experiment, and administering the SUS study. The performance results from the three experiments were compared. Usability testing was commenced while every user was logged onto the system. System usability was collected on a user's ability to complete the tasks. During the design, the researcher included methods for collecting usability data. The Web administrator controlled the addition of vocabulary and the reduction of vocabulary numbers, and also monitored activity. Time recording began when a user logged on, tracking task time, the number of errors a user made, and the number of mouse clicks that were needed for the user to complete a task. Based on the literature survey of related works, the following hypotheses were made, to be tested by the study. Jeff Sauro stated:

To increase the meaningfulness and strategic influence of usability data, analyses need to be able to represent the entire construct of usability as a single dependent variable without sacrificing precision [247].

4.11 Apparatus

An application program was developed for each experiment using Microsoft Visual Basic.Net and C Sharp. A hosting service site was hired to load the system with the URL (http://www.learningkau.com/login.aspx) for the administrator page and (http://www.learningkau.com/default.aspx) for users. The URL is linked to both three systems.

4.12 Tasks in Systems

Theoretically, vocabulary-learning tasks are different, so researchers' diffractions on these tasks, the distinction between knowing a word and using it, imply different tasks [248]. Three task themes were applied for each site. These tasks were similar for each website, and some were identical. The participants were instructed to learn each word and answer all questions. These tasks were designed to be increasingly complex, and the time that it took to learn each word was measured. With respect to accurately measuring the mouse clock, Jeff Sauro has stated that both click counts and task time are metrics for measuring efficiency—one of the key aspects of usability [247]. **Table 7** identifies three ways to perform learning tasks. Tasks were designed into easy, moderate, and hard to influence variables devised especially for this study. These tasks were designed with the usability component shown below:

Table 7: Overall Tasks

Task Number	Task Theme	Easy word task	Moderate word task	Hard word task
1	Efficiency	1. Time taken for easy word completion. 2. Numbers of error	1. Time taken for moderate word completion. 2. Numbers of error	1. Time taken for hard word completion. 2. Numbers of errors
2	Effectiveness	Percentage of successfully completed by subjects: The number of tasks correctly performed within criterion times as a percentage of tasks performance.	Percentage of successfully completed by subjects: The number of tasks correctly performed within criterion times as a percentage of tasks performance.	Percentage of successfully completed by subjects: The number of tasks correctly performed within criterion times as a percentage of tasks performance.

Table 8 shows the distribution skill that was suggested by Nation and other researchers in cases of reading and listening. The estimated targets for the new word-learning rates are approximately 3,000 words per year for required effective reading at the university level and 5,000 for academic success [249, 250]. Researchers such as Wallace (1984) suggested that approximately five to seven new words should be acquired per lesson on average, although there are some factors which may change this figure, such as classes and learners [251]. Conversely, Doff and Jones (2000) and Nation and Waring (1997) suggested eight words per lesson as a target [251, 252].

Table 8: Vocabulary Size estimation (adapted from Nation)

How large a vocabulary is needed for reading and listening?		
Skill	**Size estimate**	**Notes**
Reading	8,000– 9,000 word families	[253]
Listening	6,000– 7,000 word families	[253]
Native speaker	20,000 word families	[254]

How large a vocabulary is needed for reading and listening?		
Skill	**Size estimate**	**Notes**
		[255]

However, Nation distinguished four kinds of vocabulary, which are frequency words, academic words, technical words, and low-frequency words [256]. These words are used between nouns and verbs because they are the most common parts of speech found in natural text [257]. Most of words were taken from the Oxford Dictionary; scientific and technical terms were taken from different resources.

4.13 Sampling

The method of estimating appropriate and exact size is arguable for scholars. Salkind [258] argued that selection of an exact sampling size is impossible. Although Jorden has argued that this depends on the nature and the purpose of the investigation[37]. Conversely, the aim of the researcher and his research is to estimate a value or set of values to the population; there is no set percentage that is accurate for every population. According to Nielson [244], usability of any system, regardless of its size, can be sufficiently evaluated by 7 to 20 users. The importance of the sampling size is a different matter. Indeed, the sampling size can explain how many people should be tested to get results that reflect the targeted population. Sampling involves the selection of a subset of individuals from within a population to estimate the characteristics of the whole population. Researchers rarely survey the entire population because the cost of a census is too high. The three main advantages of sampling are that the cost is lower, data collection is faster, and—because the dataset is smaller—it is possible to ensure homogeneity and to improve the accuracy and quality of the data. Before calculating the sample size, the *confidence interval* and *confidence level* must be determined. The confidence interval is also a (margin error) plus or minus figure. To determine the sample size needed for a given level of accuracy, the conservative figure of 5% is a good choice. This will determine a general level of accuracy for the sample. Mathematics probability proves the size of the population. The following is useful for determining the size level:

The confidence level is 95% of the confidence interval, which is 50, and the computer technology population in De Montfort is about 100 students; the sample size is = 4.

4.14 The Advantage of Using Sampling

Sampling involves a smaller amount of subjects, which reduces investment in time and money. Sampling can actually be more accurate than studying an entire population because it affords researchers a lot more control over the subjects. Large studies can bury interesting correlations amongst the "noise". Statistical manipulations are much easier with smaller datasets, and it is easier to avoid human error when inputting and analysing the data.

When sampling, a researcher has two distinct choices:

- Ideally, using randomisation techniques to establish sample groups and controls if they take a representative sample of the whole population.
- Using a grouping that has been assigned to the sample size.

Researchers rarely survey the entire population because the cost of a census is too high. The three main advantages of sampling are that the cost is lower, data collection is faster, and, because the data set is smaller, it is possible to ensure homogeneity and to improve the accuracy and quality of the data.

The experiment design is planned to perform between subject designs. One of the most common experiment types is used in some scientific disciplines, especially psychology. The basic idea behind this type of study is that the subject can be part of the treatment group or the control group, but cannot be part of both. If more than one treatment is tested, a completely new group is required for each. This type has been chosen because this design lowers the chances of participants suffering boredom after a long series of tests. Each group will have 33 subjects. The total will be 96 subjects based on:

$$n = \frac{N}{1+N(e)^2}$$

Because *n* is the sample size, *N* is the population size, and *e* is the level of precision. Assuming the population size is equal to 2,000 students, there is a risk in precision of ±10% to reach a test of significance.

Calculating a sample size for the system:

Because *n* is the sample size, *N* is the population size, and *e* is the level of precision:

- Assume the population size is equal to 2,000 students. This will represent good population number with a risk in precision of ±10% to reach a test of significance.

The degree of variability in the attributes to be measured refers to the distribution of attributes in the population. The more heterogeneous a population is, the larger the sample size is that requires an adequate level of precision. The target population of which the sample was derived for this experiment was regular Arabic students studying at one of the UK universities.

For system sampling, (n = 24) subjects were chosen. The strategy followed was the convenience-sampling method because it was tested and had solid results with 20 subjects during the experimental test [259].

4.15 Independent and Dependent Variables

Variables were used to control the input and output changes of the experiments. To get experimental results, these variables were dependently, or interpedently controlled and measured to ensure consistency. They were:

1. Tasks: All subjects had exactly the same number of tasks (40 randomised vocabularies in each session) and the same distribution level was spread among all subjects. This was ensured by following criteria developed to ensure the consistency of tasks.

2. Learning effect: To ensure that the learning effect was controlled, all vocabularies were randomised and reordered to avoid this effect.

3. Task criterion time: V. Pignot-Shahov indicated that “measuring the depth of vocabulary, or measuring how well a word is known, is a trickier task than measuring how many words a learner knows” [260] Each task had a criterion time within which it was to be completed. A task would be regarded as unsuccessfully completed if not completed within its criterion time. Every item has its criterion time on all levels of the word—easy, moderate, or hard.

The DVs were grouped into matrices.

Efficiency

1. Task accomplishment time: The time taken to complete the task. Time was counted automatically during the tasks.

2. Number of errors: The number of errors occurring during each task. Errors were also counted automatically during the tasks.

Effectiveness

1. Percentage of tasks successfully completed by all subjects: This was calculated for the number of tasks completed within their criterion times.
2. Number of subjects who successfully completed all tasks: This again required all tasks to be completed within their criterion times.

Satisfaction

1. Overall satisfaction: Subject satisfaction was measured by using the SUS items.

4.16 Database SQL Server

The SQL (structured query language) server was used to store all data systems related to columns and rows. The database was modelled and designed logically (mapped conceptual schemas into relational schemas) See database system structure (**Figure 78, Appendix: E)** for more details. **Figure 78** shows a graphical representation of the sample Words database. The diagram below provides a visual overview of the structurally necessary tables of the database and the relations between the tables created during the Word standard installation. The diagram consists of 13 tables and is designed based on categorising and storing all necessary word details and exams. The focus of this thesis was to assist with vocabularies and questions. As illustrated in **Figure 79,** tables were *Word_Type, Word_Details, Exam_Details, Question_Answers, Difficult_Levels, Exams, Word-to-Word, Administrator, Student-Learning-Trac, W-Group, Word-to-Group, Learning_Type,* and *Questionnaire*. Each of these tables holds the required information from and to online learning systems of the adaptations. The SQL database server was used as a common open-source database management system.

4.17 Procedure

First, subjects were randomly assigned to different orders in the three systems. They were asked to complete four parts for the experiments. The first part was a simple survey that asked about certain characteristics (age, education level, computer usage, etc.). The survey was used to gather descriptive statistics of all subjects; the survey is shown in **Appendix: I**. The second part was a learning session for a single word and its meaning. Part three was the exam test for the words learned. Every student had to complete 40 multiple choice questions about a single word and five mixed meanings, of which one was correct. Part four was the SUS survey for collecting the overall usability system. The first task block began when the subjects logged into the system, which counted the total time for completing the experiment. The second time account was started when the experiment commenced. After completing the first part, the second part of a session started when the user clicked the 'Start' button, and then time for each word was counted separately. The count was then allocated to that word. When the user pressed 'Next', another time was recorded for the next word. This did not indicate an accurate or exact time of study word; however, during the pilot test, time was measured for each word level and for how long it took for each word to be memorised and for errors to occur. This determined the time reference for each item and created a guideline for comparing the study times for items[261].

The practical section includes pilot studies of the system. This section was intended to study and evaluate usability attributes, which measure system efficiency and effectiveness, while user satisfaction was conducted through the SUS. The pilot study was encapsulated with five users measuring and evaluating the system, which was designed with within-subject methods. The purpose was to determine and measure the criterion time for each task.

4.18 Pilot Study Results

The pilot experiment was conducted as a small scale test to evaluate feasibility of the system in all aspects of usability. In this test experiment, within-participants were designed to allow the user to compare the three interactions in the experimental platforms. The aim of the study was to discover students' perceptions about some aspects of the system and the usability of the interface. Five subjects were randomly tested in the three systems. The tests were conducted with a total of 40 selected words, which were classified as easy (16 words), moderate (12 words), or difficult (12 words) to learn. In this section, the researcher compares the three systems according to word complexity (easy, moderate, and difficult). The words and their complexity are shown in **Table 97** and in **Appendix F**. The study was conducted to collect data for reference to the original study, such as task time, error level, and word design. The majority of the participants felt that the interface was nicely designed to complete the research. Using the test carried about by the five students, the researchers now present the comparison of the three systems in terms of learning time, exam time, and errors. Time was measured in seconds using a stop clock. The times for the five students were grouped according to vocabulary complexity and systems that make comparison and presentation easy.

4.19 Data Collection for Pilot Study

4.19.1 Learning Time

Descriptive statistics for learning time for the three systems and according to word complexity are shown on **Table 9**; **Figure 6** shows the median learning for the three systems by word complexity.

4.19.2 Easy Vocabulary

On average, the students took 4.91 seconds to learn easy words using the static system, 5.02 seconds using the adaptable system, and 4.56 seconds using the adaptive system. The corresponding median times were 4.08, 4.05, and 3.28 seconds, respectively. This seems to indicate that the students learn quicker using the adaptive system, followed by the static system, and then the adaptable system. Normality tests

Table 9: Descriptive statistics of learning time for the three systems

Word Complexity	System	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
						25th (Lower Quarter)	50th (Median)	75th (Upper Quarter)
Easy Word	Static	4.91	3.36	2.02	16.50	2.85	4.08	5.10
	Adaptable	5.02	3.45	1.15	14.50	3.17	4.05	4.83
	Adaptive	4.56	3.45	2.02	14.17	2.60	3.28	4.27
Moderate Word	Static	5.31	3.11	2.02	14.17	3.28	4.27	6.05
	Adaptable	5.28	3.84	2.02	14.17	2.60	4.05	5.50
	Adaptive	6.11	4.43	2.02	14.17	3.10	4.16	9.95
Difficult Word	Static	5.14	3.02	2.02	14.17	3.17	4.06	6.14
	Adaptable	5.12	4.04	2.02	14.17	2.60	3.28	4.27
	Adaptive	5.08	3.44	2.02	14.17	3.17	4.05	5.08

Indicated that learning time was not normally distributed, consequently non parametric testing—in particular, the Wilcoxon test—was used to test whether the median times were significantly different for easy words across the three systems. Results indicate that the median learning time of 4.08 seconds for the static system was not significantly different from the median time of 4.05 seconds for the adaptable system [$p = 0.77$ (>0.05)]; similarly, there was no significant difference between the static median learning time of 4.08 seconds and that of 3.28 seconds for the adaptive system [p = 0.13 (>0.05)]; also, no significant difference between adaptable (4.05s) and adaptive (3.28s) systems [p = 0.24 (>0.05)] were found.

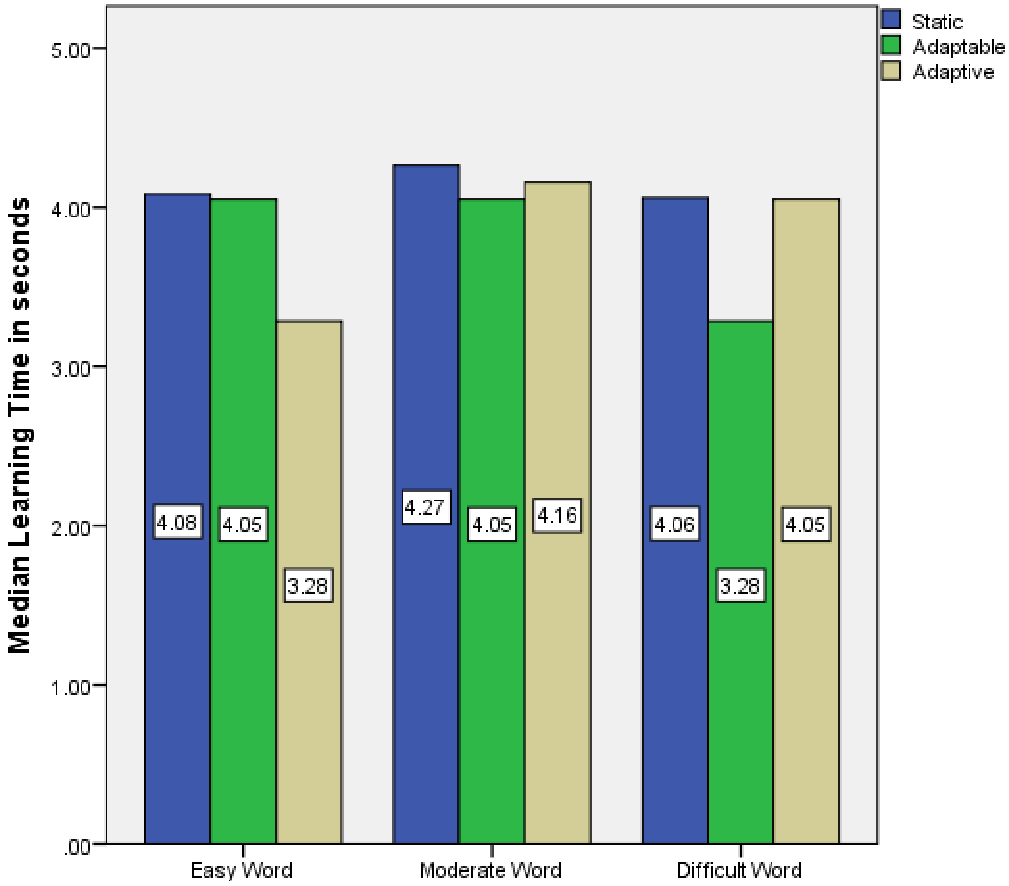

Figure 6: Median learning time

4.19.3 Moderate Vocabulary

On average, the students took 5.31 seconds to learn moderate words using the static system, 5.28 seconds using the adaptable system, and 6.11 seconds using the adaptive system. The corresponding median times are 4.27, 4.05, and 4.16 seconds, respectively. This seems to indicate that the students learn moderate words more quickly using the adaptable system, followed by the adaptive system, and then the static system.

Results from Wilcoxon tests indicate that the median learning time of 4.27 seconds for the static system was not significantly different from the median time of 4.05

seconds for the adaptable system [$p = 0.44$ (>0.05)]; similarly there was no significant difference between static median learning time of 4.27 seconds to that of 4.16 seconds for the adaptive system [$p = 0.90$ (>0.05)] or between adaptable (4.05s) and adaptive (4.16s) systems [$p = 0.31$ (>0.05)]. These learning times are taken from **Table 9.**

4.19.4 Difficult Vocabulary

On average, the students took 5.14 seconds to learn difficult words using the static system, 5.12 seconds using the adaptable system, and 5.08 seconds using the adaptive system. The corresponding median times are 4.06, 3.28, and 4.05 seconds, respectively. This seems to indicate that the students learn difficult words more quickly by using the adaptable system, followed by the adaptive and then the static system.

Results from Wilcoxon tests indicate that the median learning time of 4.06 seconds for the static system was not significantly different from the median time of 3.28 seconds for the adaptable system [$p = 0.22$ (>0.05)]; similarly, there was no significant difference between the static median learning time of 4.06 seconds and the 4.05 seconds for the adaptive system [$p = 0.44$ (>0.05)]. Also, there was no significant difference between adaptable (3.28s) and adaptive (4.05s) systems [$p = 0.31$ (>0.05)]. These learning times are taken from **Table 9.**

4.19.5 Exam Time

Descriptive statistics for exam time for the three systems and according to word complexity are shown on **Table 10**; **Figure: 7** shows the median exam times for the three systems by word complexity.

4.19.6 Easy Vocabulary

On average, the students took 12.80 seconds to complete the exam on easy words using the static system, 12.96 seconds using the adaptable system, and 12.41 seconds using the adaptive system. The corresponding median times are 12.17, 12.17, and 11.95 seconds, respectively. This seems to indicate that the students took less time to complete the exam using the adaptive system, followed by the static and the adaptable systems, which took the same times. Normality tests indicated that exam times were not normally distributed; consequently, non-parametric tests in particular. Wilcoxon tests were used to determine if the median times were significantly different for easy words across the three systems. Results indicate that the median exam time of 12.17 seconds for the static system was not significantly different from the median exam time of 12.17 seconds for the adaptable system [$p = 0.81$ (>0.05)]; similarly, there was no significant difference between the static median exam time of 12.17 seconds and the 11.95 seconds for the adaptive system [$p = 0.54$ (>0.05)]. Also, no significant difference existed between the adaptable (12.17s) and adaptive (11.95s) systems [$p = 0.47$ (>0.05)]. These learning times are taken from **Table 10.**

4.19.7 Moderate Vocabulary

On average, the students took 13.49 seconds to complete the exam on moderate words using the static system, 12.92 seconds using the adaptable system, and 12.22 seconds using the adaptive system. The corresponding median times are 12.87, 11.62, and 12.06 seconds, respectively. This seems to indicate that the students completed the exam on moderate words more quickly using the adaptable system, followed by the adaptive and then the static system. Results from Wilcoxon tests indicate that the median exam time of 12.87 seconds for the static system was not significantly different from the median exam time of 11.62 seconds for the adaptable system [p = 0.13 (>0.05)]; there was a significant difference between the static median exam time of 12.87 seconds and the 12.06 seconds for the adaptive system [p = 0.001 (<0.05)]. There was no significant difference between adaptable (11.62s) and adaptive (12.06s) systems [p = 0.10 (>0.05)]. These exam times are taken from **Table 10.**

4.19.8 Difficult Vocabulary

On average, the students took 17.27 seconds to complete the exam on difficult words using the static system, 15.37 seconds using the adaptable system, and 15.88 seconds using the adaptive system. The corresponding median times are 16.64, 14.83, and 14.30 seconds, respectively. This seems to indicate that the students completed the exam more quickly on difficult words using the adaptive system, followed by the adaptable and then the static system. Results from Wilcoxon tests indicate that the median exam time of 16.64 seconds for the static system was significantly different from the median time of 14.83 seconds for the adaptable system [p = 0.004 (<0.05)]; similarly, there was a significant difference between the static median exam time of 16.64 seconds and that of 14.30 seconds for the adaptive system [p = 0.019 (<0.05)]. There was no significant difference between adaptable (14.83) and adaptive (14.30s) systems [p = 0.76 (>0.05)]. These learning times are taken from **Table 10.**

Table 10: Descriptive statistics of exam time for three systems

Word Complexity	System	Mean	Std. Deviation	Minimum	Maximum	Percentiles 25th (Lower Quarter)	Percentiles 50th (Median)	Percentiles 75th (Upper Quarter)
Easy Word	Static	12.80	2.70	7.60	19.17	10.27	12.17	15.57
	Adaptable	12.96	3.29	8.43	22.23	10.25	12.17	14.98
	Adaptive	12.41	2.43	7.27	19.17	10.83	11.95	14.19
Moderate Word	Static	13.49	2.66	10.00	21.20	11.36	12.87	15.07
	Adaptable	12.92	3.03	9.38	22.35	10.53	11.62	14.92
	Adaptive	12.22	1.96	8.32	18.38	11.05	12.06	13.32
Difficult Word	Static	17.27	4.13	10.05	26.08	13.74	16.64	19.90
	Adaptable	15.37	4.30	9.13	23.20	11.30	14.83	19.54
	Adaptive	15.88	5.26	10.03	35.07	12.09	14.30	19.90

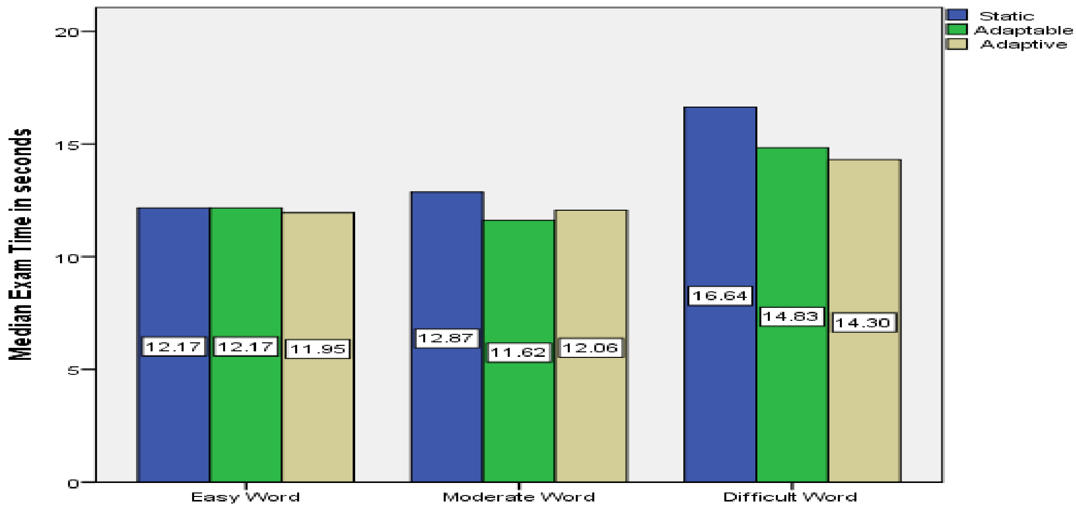

Figure 7: Median Time

4.19.9 Error Rates

The number of errors made when using the three systems by word complexity is shown in **Table 10.** For easy words using the static system, only one error was made; for the adaptable system, four errors were made, and for the adaptive system, no errors were made. Note that there were 16 easy words and 5 students, with a total of 80 occasions (16 x 5 = 80). The error rate of the static system was 1 in 80

(1.25%); for the adaptable system, it was 4 in 80 (5%); and for the adaptive system, it was 0 in 80 (0%).

For moderate words, only two errors were made using the static system; for the adaptable system, five errors were made; and for the adaptive system, two errors were made. Note that there were 12 moderate words and 5 students, with a total of 60 occasions (12 x 5 = 60). The error rate of the static system was 2 in 60 (3.33%), for the adaptable system it was 5 in 60 (8.33%), and for the adaptive system it was 2 in 60 (3.33%).

For difficult words, only one error was made using the static system. For the adaptable system, no error was made. For the adaptive system, two errors were made. Note that there were 12 difficult words and 5 students, for a total of 60 occasions (12 x 5 = 60). The error rate of the static system was 1 in 60 (1.67%); for the adaptable system it was 0 in 60 (0%); and for the adaptive system it was 2 in 60 (3.33%).

Mean error rates for all words for the three systems show an average error rate of 2.08% for the static system, 4.30%for the adaptable system, and 2.20% for the adaptive system. This shows that the static system has the least error, followed by the adaptive system and then the adaptable system.

Table 11: Error rate (%) by complexity for three systems

Word Complexity	**Number of errors / %**	**Static**	**Adaptable**	**Adaptive**
Easy Word	Number of errors	1	4	0
	% error	1.25	5.0	0.0
Moderate Word	Number of errors	2	5	2
	% error	3.33	8.33	3.33
Difficult Word	Number of errors	1	0	2
	% error	1.67	0.0	3.33

4.20 Measurement

Fraser stated that inferring word meaning is potentially a productive strategy for vocabulary learning and there is a consensus in that sense. To fulfil the objectives mentioned in **Section 4.3**, two usability parameters had to be measured first **(see Table 12).** Efficiency can be calculated by measuring the amount of effort required to accomplish certain goals or tasks [262, 263]. Thus, efficiency was measured by the time subjects took to complete tasks and by the number of errors made during the accomplishment of each task. Effectiveness can be measured in terms of whether certain goals or tasks are achieved successfully [262, 263]. Hence, effectiveness was measured by calculating the percentage of subjects who completed tasks along with the percentage of tasks completed by all subjects. To compare the effectiveness of the six conditions, a critical time for task completion was derived for each level of learning. A task would then be regarded as successfully completed if subjects completed it within the critical completion time. Satisfaction was measured by using the SUS items and asking subjects to rate their satisfaction.

Table 12: Metrics and DVs

Metric	Dependent Variables
Efficiency	1. Time taken to complete the tasks 2. Number of mouse clicks 3. Number of errors
Effectiveness	1. Percentage of tasks successfully completed 2. Number of subjects who successfully completed all tasks
Satisfaction	1. Overall satisfaction
Achievement	1. Evaluate the level of learning's knowledge.

4.21 Discussion

This chapter aims to compare the three systems of learning and exam times to look for significant differences, from which we may conclude that learning times for easy words were not significantly different in any of the three systems. Wilcoxon tests indicated no significant differences in learning times for moderate words in any of the three systems. Finally, there were no significant differences for difficult words. On average, students took 12.80 seconds to complete easy words during an exam. The corresponding medium indicates that students in adaptive system had less time to complete the exam. Therefore, normality tests indicated that exam time was not normally distributed; consequently, non-parametric tests (in particular, Wilcoxon tests) were used to test whether the median times were significantly different for easy words across the three systems. For moderate words, on average, the students took 13.49 seconds to complete the exam, which seems to indicate that the students completed the exam on moderate words more quickly, using the adaptable system, followed by the adaptive and then the static system. Results from Wilcoxon tests indicate that the median exam time of 12.87 seconds for the static system was not significantly different from the median exam time of 11.62 seconds for the adaptable system [p = 0.13 (>0.05)]; there was a significant difference between the static median exam time of 12.87 seconds to that of 12.06 seconds for the adaptive system [p = 0.001 (<0.05)]; there was no significant difference between adaptable (11.62s) and adaptive (12.06s) systems [p = 0.10 (>0.05)].This seems to indicate that the students completed the exam on difficult words more quickly using the adaptive system, followed by the adaptable and then the static system. Results from Wilcoxon tests indicate that the median exam time of 16.64 seconds for the static system was significantly different from the median time of 14.83 seconds for the adaptable system [p = 0.0.004 (<0.05)]; similarly, there was a significant difference between the static median exam time of 16.64 seconds to that of 14.30 seconds for the adaptive system [p = 0.019 (<0.05)]; there was no significant difference between adaptable (14.83) and adaptive (14.30s) systems [p = 0.76 (>0.05)]. The error rate taking from the mean error rates for all words for the three systems we see that on average, the error rate for the static system is 2.08%; for the adaptable system it is 4.3%; and for the adaptive system it is 2.20%. From this, we see that the static system has the least error followed by the adaptive system and then the adaptable system.

4.22 Summary

This chapter has documented the pilot study of experiments carried out to investigate the efficiency and effectiveness for users of different learning platforms as measures of usability. The metrics used to measure efficiency were task accomplishment time and frequency, while effectiveness was measured by calculating the number of subjects completing all tasks and the number of tasks completed successfully within task criterion times.

Chapter 5: Experiments and Data Collections

5.1 Introduction

The data were collected and designed in two phases. The first phase was system usability and was intended to measure and evaluates the data for this study, which was gathered from 96 subjects' allover four systems with equal numbers in each system's 24 subjects. The disciplines represented in the data section (see **Appendix G** for more details) were the complete sets of all figures and analyses required. This section describes two patterns of usability measurements. The first method is called "quick and dirty" and is derived from the three ISO 9241-111l usability_methods that will be described later. The "quick and dirty" method, named after the SUS, was developed by Brooke, who had great success with usability among overall systems because it is quick and easy to use and measure[238]. The SUS was developed according to the ISO 9241-111, which defines usability as a combination between different metrics measurements: 1) effectiveness is defined as a percentage of tasks successfully completed by all users with the number of users who successfully completed all tasks, 2) Efficiency is defined as task time "effort" with regard to the number of errors that occurred, and 3) overall, users' satisfactions with the interaction with the system [264]. Lewis and Sauro have described that the "quick and dirty" SUS method is divided into a two-factor structure. Eight items involve usability and two items involve learnability; thus, the advantage of the SUS use is higher. However, two items were added to SUS 10 items to measure user achievement of vocabularies [246]. For the research to find the appropriate method to be applied, a combination between the two methods of system metrics will be measured between efficiency and effectiveness, and then user satisfaction, by applying the SUS. The language interface of vocabulary in L2 has less functionality in GUI, with more system adaptation required, but learnability and memorisation are more important [238]. User satisfaction implied an overall opinion that the usability statements on the SUS scale will be evaluated for each system utilisation and seemed to elicit mixed feelings from participants. Some researchers may argue that responses to individual items on the research questionnaire are not meaningful and, therefore, individual analysis may be suspect. They proposed choosing to look at the analysis again using the SUS analysis both individually and overall, and then allowing the SUS to yield a single number representing a composite measure of the overall usability of the system. The following steps must be taken to arrive at an SUS score as proposed:

- For positive statements, subtract one from the user response.
- For negative statements, subtract five from the user response.

This scales all values from zero to four (with four being the most positive response). So the SUS score will range from 0 to 48 because there are 12 statements on the questionnaire. Some researchers will scale this up to 100, but for the present study, the researchers have decided that this is not necessary, as it will have no effect on the statistical analysis.

5.2 Aims

The aim was to evaluate these systems and also to measure users' vocabulary-learning achievements from those platforms. However, further evaluation of the users' learnability on the system usability matrix was to be obtained. This purpose of this research was to explore and determine which level of adaptation should be used in three adaptive systems as compared with the static system so that the appropriate approach and a helpful learning interface with web content could be recommended for the learning website. Fischer states that HCI is concerned with tasks, with shared understanding, and with explanations, justifications, and argumentation about action, but not with the interface [265]. In addition, it aims to explain the factors that make one approach more successful than the others. More specifically, it aims to produce a set of empirically derived guidelines for designing more usable personalised interfaces. It also aims to identify ways to influence learnability for reaching satisfaction from these aims involves answering the research question.

5.3 Objectives

To fulfil the research goals, measurement objectives had to be attained. First, the three method ISO 9241-111l usability had to be measured precisely; this included the efficiency, effectiveness, and user satisfaction. The first option was to take system measurements and the second option was to use SUS measurements. The reason to precisely measure time first was to determine the difference that would occur with if there was an error, and then to examine how learning and memorisation impact learning. Users' memorisation abilities were different from person to person, who was taken into consideration during this research; in addition, vocabularies were selected in a way that showed the difference in abilities among users. Learning time was important for indicating and influencing learning while helping to determine system functionality that could be compared between approaches.

5.4 Experimental Platform

The experimental platform was a typical Web-based online learning application for vocabulary learning. Subjects had to register first to log in, and then answer questions. After completing the testing, they were required to answer questions about usability. More specifically, each platform consisted of different techniques, but referred to the same subject. The implementation of each system was different when researching the best system for learning vocabulary. A typical Web-based online learning application examines how subjects would interact with such a system and explores how interaction metaphors affect the search time and effort. The experimental platform utilised four types of interaction conditions: static, adaptable, adaptive, and mixed-initiative approaches (**see Figure 5**).

5.4.1 Contents of Learning

Such researchers as Wallace (1984) suggested that approximately 5 to 7 new words should be acquired on average by a student per lesson [251], although there are some factors which may change this figure, such as classes, learners, and learner ability. The learning session contains 40 vocabulary items from a randomised 1000-word list that has been collected from different categories to measure the level of learning from different disciplines and include easy, moderate, and hard items. Groups in every application have different learning methods that are systemised or require user involvement.

5.4.2 Static Platform

For the static platform, the contents, layout, and learning with words meaning did not change during the course of use. The goal was to design the ideal platform to do the required tasks as efficiently as possible. To do this, the content was used according to predetermined websites and similar to learning websites, such as Rosetta stone. Rosetta Stone is a type of learning software that uses sound, speech, and multiple choice questions to learn not only English, but many other languages as well [266].

5.4.3 Adaptive Platform

In the case of the adaptive platform (system decision approach of measuring word time), the layout, content, and the method of learning changed automatically during use. The goal was to design a helpful website which measures the word levels themselves and the ways in which students learn new words by looking at mistakes, learning times, and the level of leaps that occurs (see **Figure 8** for more details). Therefore, subjects were not able to see what happened based on previous measures. For example, if a subject wanted to learn a word, such as “extravagant”, the word in first stage was an easy word. The student struggled with learning the meaning of this word in the static system. The meaning of the word is “lacking restraint in spending money or using resources”. In the adaptable system, the word could be learned by using synonyms or antonyms. “Extravagant” means:

The word Excessive or odd, extremist, life. The word could be learned by any of these synonyms. An adaptive system will measure the best way of learning. If a student chooses synonyms or antonyms time and correctness will be the best measure for each vocabulary word **(See Figure 9)**. When a student wants to learn a specific word, the adaptive system will automatically determine the best method of learning.

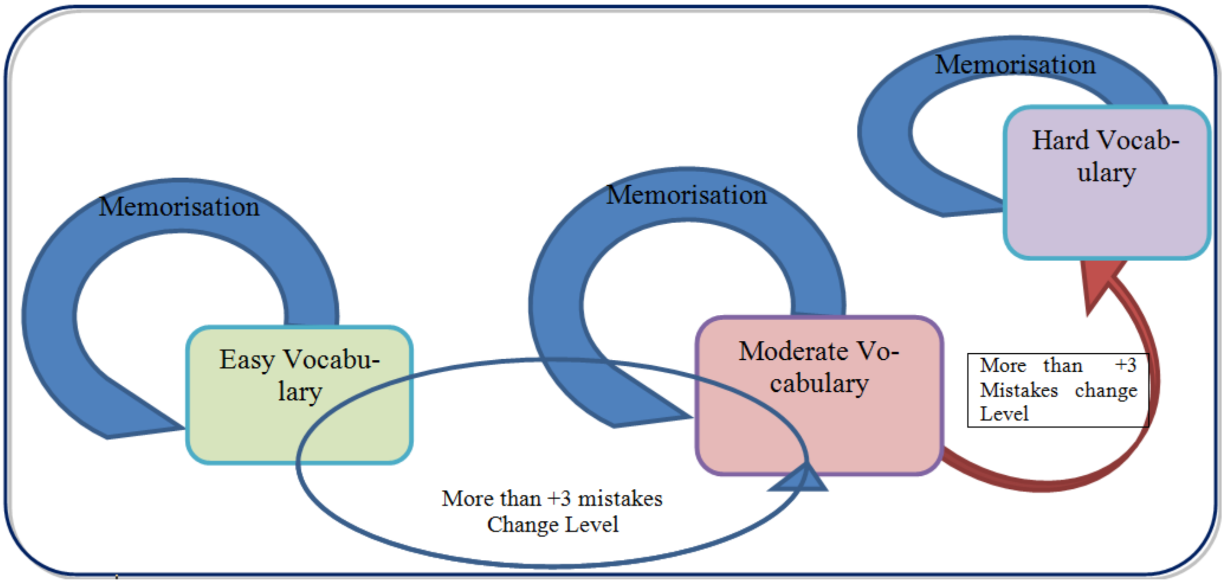

Figure 8: Adaptation Methods

The leap items **(see Figure 9**) from the static system to the adaptable system (if there are more than three mistakes) will leap to next level which is considered as moderate vocabulary. If moderate mistakes occur more than three times, the system with consider the word difficult and it will be marked as such. These systems will assist the student in learning by using what is called the jump level. Changing leaps depends on subject's learning times, and mistakes occur by means of two algorithms: measure times and calculated mistakes. These were adopted as being the two most popular algorithms, used by Microsoft and were suggested by David Ahlstroem [267]. The jump method is adapted from the new menu creation and the jumping Menu.

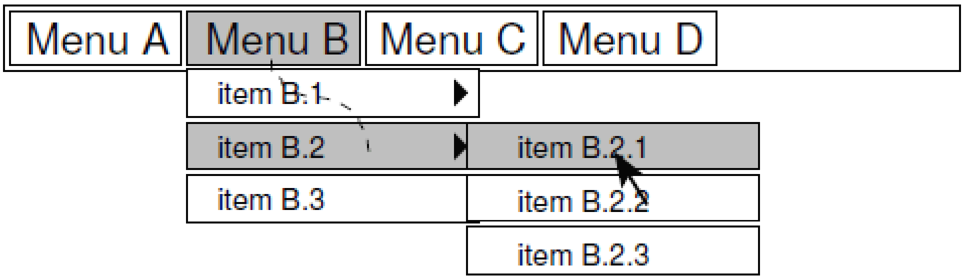

Figure 9: Jump methods scenarios (adapted from Jumping Menu)

5.4.4 Adaptable Platform

In the adaptable platform (only user approach, user decision), the layout and contents were changed by subjects before system used in the login. The goal was to involve students in choosing a vocabulary-learning method. The learning style the user chooses is one way to learn synonyms or antonyms. The content and layout of the interface changes as does the method of studying, depending on what the user chooses. It is important to respect the user's privacy, but measurements of achievement are taken into account for the sake of the study. The main page provides two choices for the user. This is because some of the early studies suggested the need to examine full-featured versus reduced interfaces. When the student begins, vocabulary will randomly be displayed at different levels of complexity. The level of complexity is predetermined and manageable (see **Figure 9**).

5.4.5 Mixed-Initiative Platform

The mixed-initiative (complained approach between user decision and system measure) is a condition state, which determines the exact and most-accurate method of word-establishment learning. The goal is to ensure that every vocabulary word at every level of complexity is measured precisely. The mixed-initiative algorithm was dynamically determined based on the most frequent and recent method of learning vocabulary. The difference between advantage and the disadvantage will drive new techniques might be used to overcome a problem to fulfil any needs. Researchers in field interaction have decided that, in certain areas, control must be predetermined. When customising user interface control, the action and layout for a user request is the decision in adaptability by user [268]. Conversely, adaptivity is system controlled [268]. Mixed-initiative is a condition state which companies the control of both approaches to alleviate the disadvantages and increase the advantages of system changes [31].

5.5 Experimental Hypotheses

The aim of this study was to measure the usability (efficiency, effectiveness, and learning achievements) and satisfaction so data that have been collected are static, adaptive, and adaptable in online learning vocabulary. Based on the literature review of the related work, the following questions and hypotheses were made to be tested in the study. The aim of the experiment was to measure the efficiency, effectiveness, learning achievements, and satisfaction of the adaptive (system approach and decision), adaptable (user approach and decision), and mixed-initiative approaches (mixed between user and system approaches) and to validate the evaluation test sets of hypotheses in usability measures. The questions and the hypotheses lie on these points, and then break into sub-hypotheses:

Q1: Is the adaptable (user approach and decision), online learning system more efficient in assisting online learning vocabulary than the static online learning system?

Q2: Is the adaptive (system approach and decision), online learning system more effective in assisting online learning vocabulary than the static online learning system?

Q3: Is the adaptable (user approach and decision), online learning system more effective in assisting online learning vocabulary than the adaptive (system approach and decision), online learning system?

Q4: Do adaptable (user approach and decision), and adaptive (system approach and decision), user systems score higher achievement test results compared to static user systems?

Q5: Will the adaptable (user approach and decision), and adaptive (system approach and decision), approaches be preferable to the static approach?

Hypothesis 1- The search for a significant difference exists in the usability metrics (efficiency, effectiveness, learning achievements, and satisfaction) of each the website.

This is used to validate the adaptation online learning technique on the three websites. If a significant difference is found between the three websites and usability metrics are related to every approach, this will validate the usability as an accurate predictor to every task. The main hypothesis and sub-hypothesis are as follow for each metric:

The hypotheses related to **efficiency** are:

H1: The **adaptable** (user approach, and decision), online learning approach is more **efficient** in assisting online learning vocabulary than the **static** online learning approach.

H1-1: The **adaptable** (user approach, and user decision), online learning approach is more **efficient** in assisting in the learning of **easy** vocabularies than the **static** online learning approach.

H1-2: The **adaptable** (user approach, and decision), online learning approach is more **efficient** in assisting in the learning of **moderate** vocabularies than the **static** online learning approach.

H1-3: The **adaptable** (user approach, and decision), online learning approach is more **efficient** in assisting in the learning of **difficult** vocabularies than the **static** online learning approach.

The hypotheses related to **error rates** are:

H2: The **adaptive** (system approach and decision), and **adaptable** (user approach, and decision), online learning approaches will be more **efficient** than the **static** online learning approach in terms of error rates.

H3: The **adaptive** (system approach, and decision), online learning approach will be more **efficient** than the **adaptable** (user approach, and decision), online learning approach in terms of error rates.

The hypotheses related to **effectiveness** are:

H4: The **adaptive** approaches (system approach, and decision), will be more **effective** than the **static** approach in terms of completely gaining vocabularies successfully.

H4-1: The **adaptive** (system approach, and decision), online learning approach will be more **effective** than the **static** online learning approach in terms of completely gaining **easy** vocabularies successfully.

H4-2: The **adaptive** (system approach, and decision), online learning approach will be more **effective** than the **static** online learning approach in terms of completely gaining **moderate** vocabularies successfully.

H4-3: The **adaptive** (system approach, and decision), online learning approach will be more **effective** than the **static** online learning approach in terms of completely gaining **difficult** vocabularies successfully.

H5: The **adaptive** (system approach, and decision), online learning approaches will be more **effective** than the **adaptable** (user approach, and decision), online learning approach in terms of completely gaining vocabularies successfully.

H5-1: The **adaptive** (system approach, and decision), online learning approaches will be more **effective** than the **adaptable** (user approach, and decision), online learning approach in terms of completely gaining **easy** vocabularies successfully.

H5-2: The **adaptive** (system approach, and decision), online learning approaches will be more effective than the **adaptable** (user approach, and decision), online learning approach in terms of completely gaining **moderate** vocabularies successfully.

H5-3: The **adaptive** (system approach, user decision), online learning approaches will be more effective than the **adaptable** (user approach, and decision), online learning approach in terms of completely gaining **difficult** vocabularies successfully.

H6: Adaptive (system approach, user decision), and **adaptable** (user approach, and decision), online learning approaches will be more **satisfactory** to the **static** online learning approach.

H7: The **achievement** test results for users of the **adaptive** (system approach, user decision); online learning approach will differ from those of users using **adaptable** (user approach, and decision), and **static** online learning approaches.

To analyse the results, descriptive and inferential statistics will be used. Descriptive statistics will be used to describe, compare, and relate variables. Although inferential statistics will be used to estimate parameters and test statistical hypotheses, inferential statistics apply the logic of hypotheses tested to examine the statistical significance between variables and, conventionally, the 5% level of significance (*p*-value = 0.05) [269].

5.6 Experimental Methods

The hypothesis listed above was tested empirically using within-subjects (or within-participants) design to allow the user to compare the three interactions and rank the preferred one to measure usability metrics, efficiency, and effectiveness; between-subjects design was allowed for user satisfaction in online learning vocabularies. Regardless of the advantage, the reason for this design is to avoid any dropout rates and biases that may accrue while using within-subject design; this will lead to a “blank slate” reaction. A random combination of 40 easy, moderate, and hard vocabulary words were used. As soon as the user was assigned to the system, the time needed to learn the vocabulary was measured. During the pilot test, the number of vocabulary words was reduced from 50 to 40 because subjects were becoming unhappy with the time testing. One of the disadvantages of the between-subject is slow time and learning effects.

5.7 Experimental Design

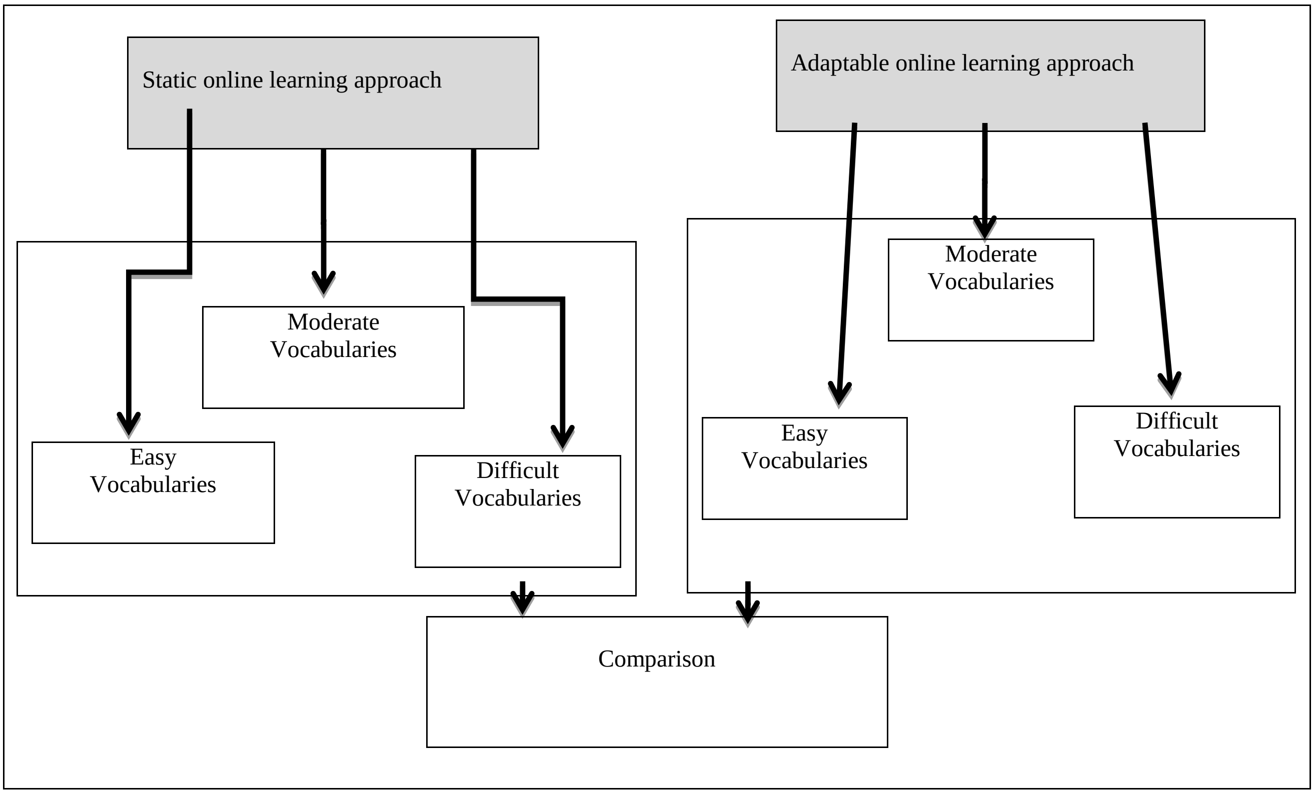

Figure 10: Plan of experiment for both learning and exam time

This experiment followed a within-subjects design and was designed to compare online learning vocabulary.

5.7.1 Tasks

All subjects were asked to accomplish the same group of tasks. These tasks were provided to assist subjects in learning how to perform the vocabulary tasks. Subjects were informed if they were spending enough time on each vocabulary task. Tasks were designed at three levels of complexity: easy, medium, and difficult. To avoid the impact of the learning effect, the order of complexity was varied between subjects. To ensure a variety of complexity, a design guideline was followed. More specifically, the number of available items, their position in the list, the number of requirements, and the amount of guidance needed were considered when designing the tasks (Table 13). For each task, the subjects were advised to learn 40 vocabulary words recall them in each exam.

Table 13: Task Design

Category	Easy Tasks	Medium Tasks	Complex Tasks
Number of requirements	All correct vocabulary	All correct vocabulary	All correct vocabulary
Guidance type	Subjects directed to learn and recall	Subjects directed learn and recall	Subjects directed learn and recall
Number of clicks required with no returns	1 to 40	1 to 60	More than 60
Time of requirements	Yes	Yes	Yes
Number of items in each system	40	40	40
Mistakes occurred	None	+ 3	+ 3

5.7.2 Task Management and Measurements

Providing a proper amount of time for each learning type and level of complexity was considered. To produce an effective evaluation regarding time criteria, a pilot study was proposed to manage and determine time level of criterion. Therefore, the design selected and relied task time to learn, memorise, and recall within criterion time for each vocabulary level and three different systems. Effectiveness was measured in terms of whether goals are met or tasks are completed successfully. The calculation is based on the percentage of subjects who completed tasks and the percentage of tasks completed by all users. To compare task effectiveness across a critical time period, or criterion time measured and were collected during the pilot study.

Table 14: The ideal time criterion tasks for all system levels of learning

Level	Tasks		Criterion Time (seconds)	Learning Time Scheme		
	Task code/	Description		Static	Adaptable	Adaptive
Simple	T1	Easy Learning Words	04:83	04:91	05:02	04:56
	T2	Exam Accm Time	12:72	12.80	12.96	12:41
Moderate	T3	Moderate Learning Words	07:31	05:31	10:50	06.11
	T4	Exam Accm Time	12:52	12:41	12:92	12:22
Complex	T5	Difficult Learning Words	09:00	05:14	08:50	12:15
	T6	Exam Accm Time	16:17	17:27	15:37	15:88
Antonyms	T7	Learning Words, Time	05:15	04:58	05:30	05:57
	T8	Exam Accm Time	13:22	N/A	13:40	13:03
Synonym	T9	Learning Words, Time	05:06	N/A	05:02	05:10
	T10	Exam Accm Time	11.84	N/A	12:10	11:58

The task types were calculated and categorised to the level of complexity. All effectiveness was calculated in terms of number of tasks completed successfully. The aim was to calculate learnable tasks and recall vocabulary tasks.

5.8 Independent and Dependent Variables

5.8.1 DVs:

Dependent variables which is a variable that stands alone and isn't changed by the other variables during experiment measure and must be defined and assigned for vocabulary to investigate the usability for comparison [270]. The outcome depends on controlling the DV and reflects precise results (see **Table 15**).

Table 15: Summary of DVs

Characteristics	Code	DVs
Effectiveness	DV1	Percentage of Tasks Completed Successfully (TCS)
	DV2	Number of subjects who completed all the tasks (NSC)
Efficiency	DV3	Task Accomplishment Time (TAT)
	DV4	Error Rate (ER)
Knowledge	DV5	Achievement Test (AT)
User attitude	DV6	User Satisfaction (US)

The representation of these characteristics needs to be quite recorded and precisely measured. These variables can be orderly continuous, discrete and categorical [271]. Based on Table: 16 summarised the DVs measured:

Table 16: DV description

Code	Description
DV1	Percentage of Tasks Accomplishment Successfully (TAS) was assigned to continuous completed tasks. In this task involved the item vocabulary guessing was wright to determine the task accomplishment.
DV2	Number of subjects who completed all tasks (NSC): who completed all tasks successfully
DV3	Task Completed Time (TCT): user's duration time during completed tasks. To calculate the time taken during accomplishes the task. The unit used for calculating time is Seconds and milliseconds.
DV4	Error Rate (ER) all obstacles occurred during completed a task is regarded as an error this includes return to the vocabulary more than once and time spent more than normal.
DV5	Achievement Test (AT) was administered to evaluate the level of user's knowledge.
DV6	User Satisfaction (US) upon answering pre-questionnaires user's satisfaction was measured overall comfortable of the systems. The SUS approach was applied to measure user's satisfied score.

5.8.2 IVs:

IVs which are manipulated and controlled in an experimental context to determine the out come's effect and ensure its consistency which are[271] see **Table: 17:**

Table 17: Summary of IVs

Codes	**IVs**	**Condition**
IV1	Task	All subjects had exact numbers tasks at the same level of complication (easy, moderate, and difficult).
IV2	Vocabulary selection	All subjects within the same group were assigned the same level of sets of selection vocabulary—one correct answer and four randomised, automatically generated, incorrect meanings.
IV3	Learning effect	To ensure that the learning effect was controlled in the study, the subjects were assigned randomly to one environment and to different groups of tasks.
IV4	Task criterion time	Each task had a criteria time which had been designed and tested during the pilot test.

5.9 Procedure

Subjects and vocabulary were randomly assigned. A questionnaire was then used to obtain information on user demographics, education, and computer experience. During this experiment, each group was assigned 40 vocabulary items. The task began as soon as the subject completed the first questionnaire, and the learning task was considered completed once the student moved to the exam task. At the same time, the student was able to return for freedom of learning and memorising. If the subject used the back button, the system considered it an error by default. This procedure applies throughout the duration of the exam.

5.10 Subjects

All 24 subjects were Arabic speakers from Saudi Arabia. Subjects were undergraduate and graduate students from both Durham and DMU. The subjects were both male and female. The researchers remained in contact with them to measure experiment conditions. Subject size selections were chosen as suggested by Rigas, Alsuraihi, and Nelson in relevant studies and relied on these studies. The static online learning approach was direct-learning vocabulary and one direct-meaning; the vocabulary level was easiest and difficulties were collected prior to building the system. Adaptation techniques have determined depending on of vocabulary levels, easy, moderated and difficult, by collecting error measurements from each type of vocabulary; in addition time was measured for each vocabulary type with task criteria time that was measured and designed during the pilot study test.

5.11 Results of System Usability

5.11.1 System Efficiency Analysis between Adaptable and Static

To analyse and evaluate system **efficiency**, Q1 asked if the **adaptable** (user approach and decision), online learning approach is more efficient in assisting with online learning vocabulary than the **static** online learning approach. The question was divided into three statements and given to three different groups of users recruited to test different systems—**static**, **adaptable** (user approach and decision), and **adaptive** (user approach and decision)—to measure system **efficiency** from task accomplishment time and to measure errors that occurred during task completion. (Is **Adaptable** (user approach and decision), online learning approach more **efficient** in assisting learning **easy** vocabularies than **static** online learning approach?). **Table18** shows the statements that evaluate efficiency. To analysis this question null hypotheses were formulated according to the questionnaire items as shown in (**Table: 18).**

Table 18: Statements of Q1 null hypotheses (adaptable and static groups)

	NH1 There is no difference between the means of the adaptable online learning approach and the static online learning approach in assisting in the learning of vocabularies	
	Statement	Null hypotheses
I	The **adaptable** online learning approach is more **efficient** in assisting in the learning of **easy** vocabularies than the **static** online learning approach.	*NH1.1 There is no difference between the means of the adaptable online learning approach and the static online learning approach in assisting with the learning of easy vocabularies*
2	The **adaptable** online learning approach is more **efficient** in assisting in the learning of **moderate** vocabularies than the **static** online learning approach.	*NH1.2 There is no difference between the means of the adaptable online learning approach and the static online learning approach in assisting with the learning of moderate vocabularies*
3	The **adaptable** online learning approach is more **efficient** in assisting in the learning of **difficult** vocabularies than the **static** online learning approach.	*NH1.3 There is no difference between the means of the adaptable online learning approach and the static online learning approach in assisting with the learning of difficult vocabularies*

5.11.1.1 Normality Distribution Test

Normality tests indicated that learning times were not normally distributed; consequently, non-parametric tests, in particular the Mann-Whitney U test, were used to test whether the mean times were significantly different for easy vocabularies across the two conditions. To compare between two means if significant have come from different students groups: Group B1 and Group B2. Results indicate that there was a significant difference between the static online learning approach and the adaptable online learning approach for easy vocabularies [*p* = 0.001> [0.05)]. For easy online learning vocabulary comparison groups, the typical mean rank of the static group was 34.79 and the typical mean rank of the adaptable group was 14.21. Therefore, the Mann-Whitney U score was 41, the significance associated with the *p*-value was .001, which is less than 0.05, so that the NH will be rejected; this means the adaptable online learning was more efficient in assisting learning than the in static group (See **Table 19**).

Table 19: Mean rank results of easy vocabularies between static and adaptable groups

Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	*p*-value
Static	24	34.79	835	41	0.001
Adaptable	24	14.21	341		

Normality tests for moderate online learning vocabulary compassion groups for *p*-value [*p* = 0.001> [0.05)] showed that the typical rank of the static group was 12.50 and the typical rank of the adaptable group was 36.50. Therefore, the Mann-Whitney U score was 31, the significance associate with the *p*-value was 0.001, which is less than 0.05, so that the NH will be rejected; this means that static online learning is more efficient in assessing than the adaptable online learning group **(Table: 20).**

Table 20: Mean Rank results of moderate vocabularies between static and adaptable groups

Ranks					
Group	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	***p*-Value**
Static	24	12.5	300	31	0.001
Adaptable	24	36.5	876		

Normality tests for difficult online learning vocabulary compassion groups for [*p*=0.001> [0.05)] showed the typical rank of the static group was 35.50 and for the typical rank adaptable group was 13.50. Therefore, the Mann-Whitney U score was 24, the significance associate with the *p*-value was 0.001, which is less than 0.05, so that the NH will be rejected; this means that adaptable online learning is more efficient in assessing than the static online learning group (**Table 21**).

Table 21: Mean rank results for difficult vocabularies between static and adaptable groups

Ranks					
Group	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whinny U**	***p*-Value**
Static	24	35.5	852	24	0.001
Adaptable	24	13.5	324		

Table 22: Statements of Q1 null hypotheses test results for online learning efficiency of two groups

Null hypotheses	Result
NH1 There is no difference between the means of the adaptable online learning approach and the static online learning approach in assisting with learning vocabularies between two student groups.	Rejected
NH1.1 There is no difference between the means of the adaptable online learning approach and the static online learning approach in assisting with learning easy vocabularies between two student groups.	Rejected
NH1.2 There is no difference between the means of the adaptable online learning approach and the static online learning approach in assisting with learning moderate vocabularies between two student groups.	Rejected
NH1.3 There is no difference between the means of the adaptable online learning approach and the static online learning approach in assisting with learning difficult vocabularies between two student groups.	Rejected

5.11.2 System Efficiency Analysis Static and Adaptive Approaches

To analyse and evaluate system efficiency, Q2 asked if the adaptive online learning approach is more efficient in assisting online learning vocabulary than the static online learning approach. The question was divided into three statements and given to three different groups of users recruited for testing different systems (static, adaptable, and adaptive) to measure system efficiency from task accomplishment time and errors that occurred during task completion. Table20 shows the statements that evaluate efficiency. To analyse this question, null hypotheses were formulated according to the questionnaire items as shown in **Table 23**.

Table 23: Statements of Q2 null hypotheses of adaptive and static groups

	NH2 There is no difference between the means of the adaptive online learning approach and the static online learning approach in assisting learning vocabularies	
	Statement	Null hypotheses
I	The adaptive online learning approach is more efficient in assisting in the learning of easy vocabularies than the static online learning approach.	*NH2.1 There is no difference between the means of the adaptive online learning approach and the static online learning approach in assisting with the learning of easy vocabularies*
2	The adaptive online learning approach is more efficient in assisting in the learning of moderate vocabularies than the static online learning approach.	*NH2.2 There is no difference between the means of the adaptive online learning approach and the static online learning approach in assisting with the learning of moderate vocabularies*
3	The adaptive online learning approach is more efficient in assisting in the learning of difficult vocabularies than the static online learning approach.	*NH2.3 There is no difference between the means of the adaptive online learning approach and the static online learning approach in assisting with the learning of difficult vocabularies*

5.11.2.1 Normality Distribution Test

Normality tests indicated that learning time was not normally distributed; consequently, the non-parametric test, the Wilcoxon test in particular, was used to test whether the mean times were significantly different for easy and moderate vocabularies across the two conditions, but not significantly different in difficult online learning vocabularies. To compare between the two means of rank if significant have come from different students groups; Group B1 and Group B2 results indicate that there was a significant difference between the static online learning approach and the adaptive online learning approach for easy and moderate vocabularies [p = 0.001 > (0.05)]. For easy online learning vocabulary compassion groups, the typical rank of the static group was 35.21 and the typical rank of the adaptive group was 13.79. Therefore, the Mann-Whitney U score was 31 and the significance associated with the p-value was 0.001, which is less than 0.05, so that the NH will be rejected. This means that the adaptive online learning group was more efficient in assisting learning than the static group (see **Table 24)**.

Table 24: Mean rank test results for easy vocabularies between static and adaptive groups

Ranks					
Group	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	***p*-Value**
Static	24	35.21	845		
Adaptive	24	13.79	331	31	0.001

Normality tests for moderate online learning vocabulary compassion groups the typical rank of the static group at 12.50 and the typical rank of the adaptive group at 36.50. Therefore, the Mann-Whitney U score was 32 and the significance associated with the *p*-value was 0.001, which is less than 0.05, so that the NH is rejected; this means that static online learning is more efficient in assessing than the adaptable online learning group (see **Table 25**).

Table 25: Mean rank result for moderate vocabularies between static and adaptive groups

Ranks					
Groups	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	***p*-Value**
Static	24	12.5	300		
Adaptive	24	36.5	876	32	0.001

For difficult online learning vocabulary compassion groups, the typical rank of the static group was 23.85 and the typical rank of the adaptive group was 25.15. Therefore, the Mann-Whitney U score was 272, the significance associated with the *p*-value was 0.748, which is more than 0.05, so that the NH is retained; this means that there is no significant difference between adaptive (system approach and decision), online learning and static online learning group (see **Table 26)**.

Table 26: Mean rank test of difficult vocabularies between the static and adaptive groups

Ranks					
Groups	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	***p*-Value**
Static	24	23.85	572.5		
Adaptive	24	25.15	603.5	272	0.748

Table 27: Statements of Q2 null hypotheses test results of online learning efficiency of the two test groups

Null hypotheses	Result
NH2 There is no difference between the means of the adaptive online learning approach and the static online learning approach in assisting in learning vocabularies between two student groups.	*Rejected*
NH2.1 There is no difference between the means of the adaptive online learning approach and the static online learning approach in assisting with learning easy vocabularies between two student groups.	Rejected
NH2.2 There is no difference between the means of the adaptive online learning approach and the static online learning approach in assisting with learning moderate vocabularies between two student groups.	Rejected
NH2.3 There is no difference between the means of the adaptive online learning approach and the static online learning approach in assisting with learning difficult vocabularies between two student groups.	Accepted

5.11.3 System Efficiency Analysis between Adaptive and Adaptable Approaches

To analyse and evaluate the system efficiency, Q3 asked if the adaptive (system approach and decision), online learning approach is more efficient in assisting online learning vocabulary than the adaptable (user approach and decision), online learning approach. The question was divided into three statements and given to three different groups of users who were recruited to test different systems (adaptive and adaptable) to measure system efficiency from the task accomplishment times and the errors that occurred during task completion. **Table 28** shows the statements that evaluate efficiency. To analyse this question, null hypotheses were formulated according to the questionnaire items, as shown in **Table 28**.

Table 28: Statement of Q3 null hypotheses between adaptive and adaptable groups

	NH3 There is no difference between the means of the adaptive online learning approach and the adaptable online learning approach in assisting with learning vocabularies	
	Statement	Null hypotheses
I	The adaptive online learning approach is more efficient in assisting in the learning of easy vocabularies than the adaptable online learning approach.	*NH3.1 There is no difference between the means of the adaptive online learning approach and the adaptable online learning approach in assisting with the learning of easy vocabularies.*
2	The adaptive online learning approach is more efficient in assisting in the learning of moderate vocabularies than the adaptable online learning approach.	*NH3.2 There is no difference between the means of the adaptive online learning approach and the adaptable online learning approach in assisting with the learning of moderate vocabularies.*
3	The adaptive online learning approach more efficient in assisting learning difficult vocabularies than adaptable online learning approach.	*NH3.3 There is no difference between the means of the adaptive online learning approach and the adaptable online learning approach in assisting with the learning of difficult vocabularies.*

5.11.3.1 Normality Distribution Test

Normality tests indicated that learning time was not normally distributed; consequently non-parametric tests, the Wilcoxon test in particular, was used to test whether the mean times were significantly different for easy, moderate, and difficult vocabularies across the three conditions; no significant difference appeared in easy and moderate online learning vocabularies, but there was significant different in difficult online learning time. Comparing between two means of rank for significant different between students groups: Group B1 and Group B2. Results indicate that there was no significant different between the adaptive online learning approach and the adaptable online learning approach for easy vocabularies [p = 0.460 > (0.05)]. For easy online learning vocabulary compassion groups, the typical rank of the adaptable group was 25.98 and the typical rank of the adaptive group was 23.02. Therefore, the Mann-Whitney U score was 252 and the significance associated with the p-value was 0.460, which is more than 0.05, so that the NH will be accepted; this means there were no significance differences between adaptive (system approach and decision), and adaptable (user approach and decision), online learning groups (see **Table 29**).

Table 29: Mean rank test results for easy vocabularies between adaptable and adaptive groups

Rank					
Group	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	***p*-value**
Adaptable	24	25.98	623.5	252	0.460
Adaptive	24	23.02	552.5		

The normality test for moderate online learning vocabulary comparison groups the typical rank of the adaptable (user approach and decision), group was 21.04 and the typical rank adaptive group was 27.96. Therefore, the Mann-Whitney U score was 205 and the significance associated with the *p*-value was 0.084, which is more than 0.05, so that the NH will be accepted; this means there were no significance differences between the adaptable (user approach and decision), online learning and adaptive groups (see **Table 30**).

Table 30: Mean rank test for moderate vocabularies between adaptable and adaptive groups

Rank					
Group	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	***p*-Value**
Adaptable	24	21.04	505	205	0.084
Adaptive	24	27.96	671		

Normality tests for difficult online learning vocabulary compassion groups the typical rank of the adaptable group was 13.71 and the typical rank adaptive group was 35.29. Therefore, the Mann-Whitney U score was 29 and the significance associated with the *p*-value was 0.001, which is less than 0.05, so that the NH will be rejected; this means there was a significant difference between the adaptive (system approach and decision), online learning and Adaptive (system approach and decision), online learning groups (see **Table 31**).

Table 31: Mean rank for difficult vocabularies between adaptable and adaptive groups

Ranks					
Group	**N**	**Mean Rank**	**Sum of Ranks**	**Mann Whitney U**	***p*-Value**
Adaptable	24	13.71	329	29	0.001
Adaptive	24	35.29	847		

Table 32: Statements of Q3 null hypotheses of test results in online learning efficiency groups

Null hypotheses	Result
NH3 There is no difference between the means of the adaptive online learning approach and the adaptable online learning approach in assisting with learning vocabularies between two student groups.	Accepted
NH2.1 There is no difference between the means of the adaptive online learning approach and the adaptable online learning approach in assisting with learning easy vocabularies between two student groups.	Accepted
NH2.2 There is no difference between the means of the adaptive online learning approach and adaptable online learning approach in assisting learning moderate vocabularies between two student groups	Accepted
NH2.3 There is no difference between the means of the adaptive online learning approach and adaptable online learning approach in assisting learning difficult vocabularies between two student groups	Rejected

5.11.4 System Error Rates Analysis

Table 33 shows the total errors for all subjects for every system. An error was recorded when a subject selected a targeted condition and the system did not respond to achieve its target. All hypotheses indicated in this section were rejected or so depends on the error difference between each approach. Findlater and McGrenere have compared the menu performance in speed and error rate to distinguish better performance in every platform [31].

Table 33: Frequency of user error

System	Learning Time					Exam time				Sum
Static	4	7	2	2	1	1	3	3	2	81
Adaptable	3	5	6	1	2	1	2	1	1	23
Adaptive	3	4	5	2	2	2	1	3	1	25
Total	10	16	13	5	5	4	6	7	4	75

Frequency of user error can be seen in the adaptable (user approach and decision), platform, which is lower than both the static and adaptive (system approach and decision), platforms in both learning time and exam time. **Figure 11** and **Table 33** show the level of error frequency occurrence separately for learning times and exam times.

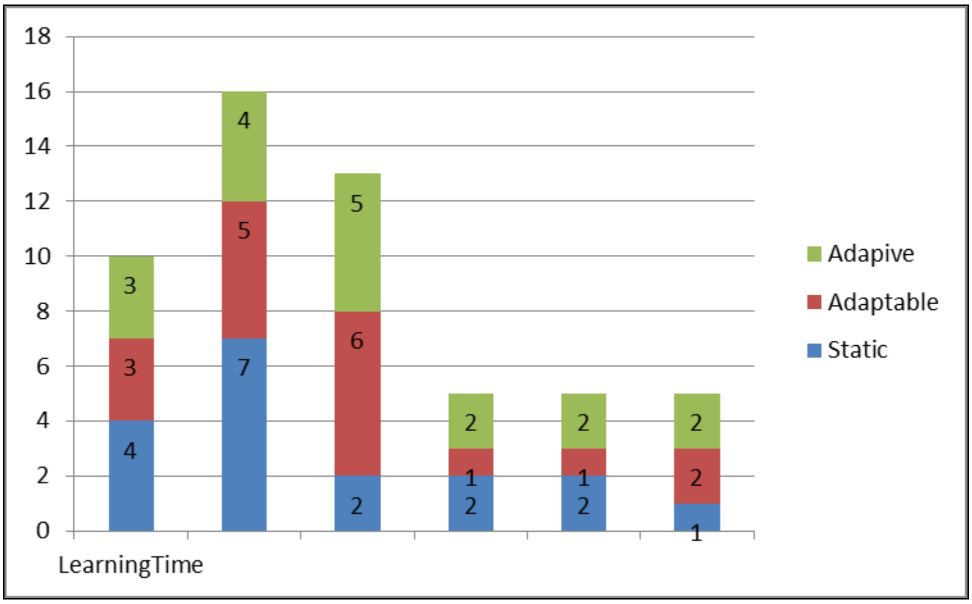

Figure 11: Compared error frequencies in three platforms during learning time

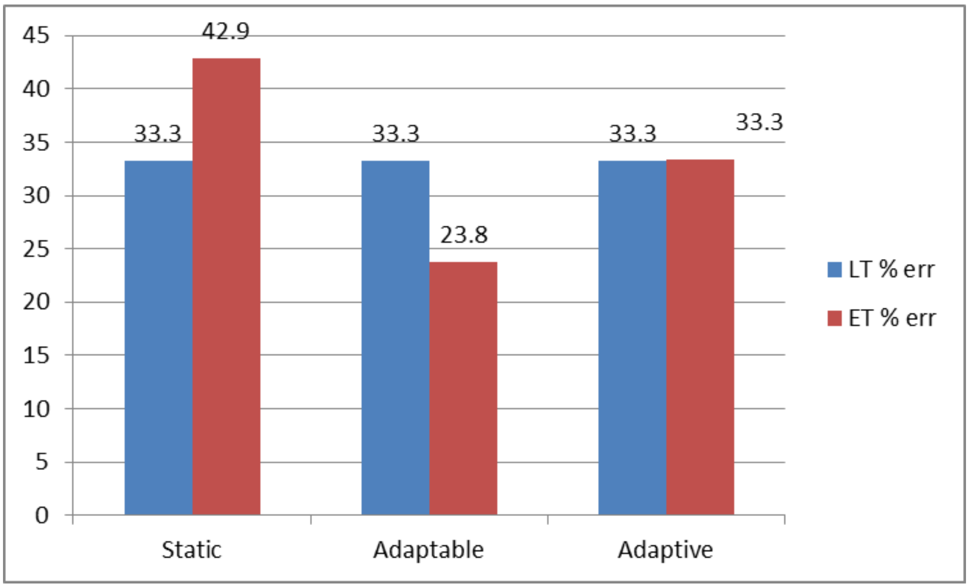

Figure 12: Compared error frequencies in three platforms during exam time

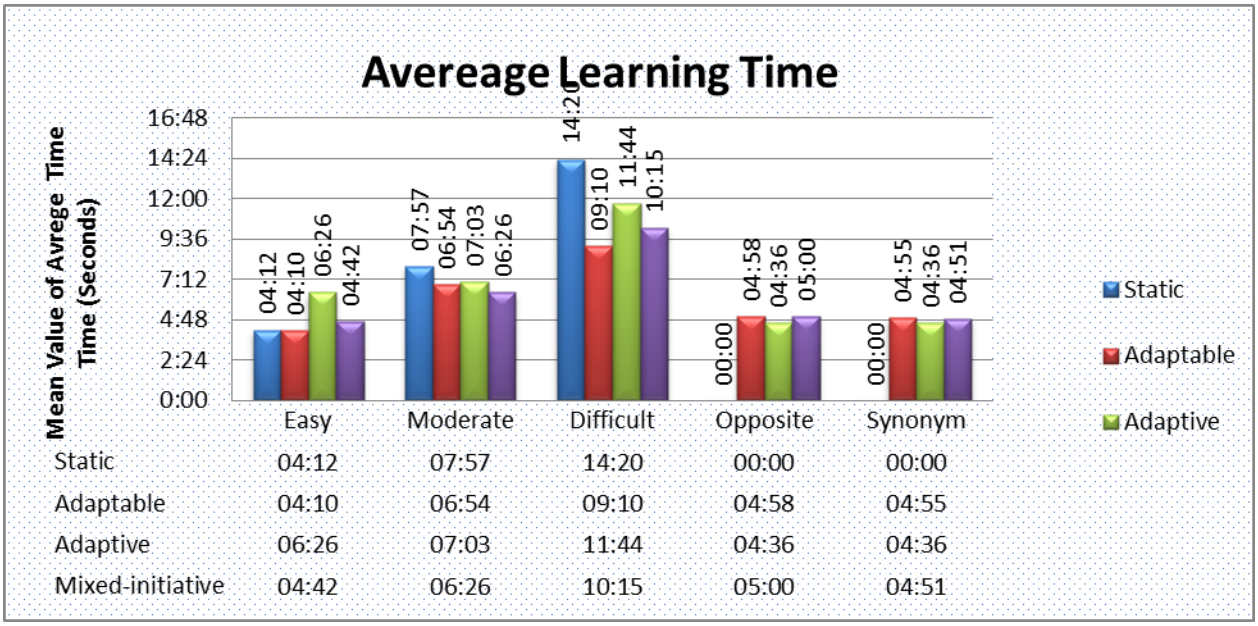

Figure 13: Efficiency of learning time in term of mean accomplishment time

Figure 13 shows that overall, subjects' performances were faster in the adaptable easy-learning tasks (04:10) than in the static (04:12), mixed-initiative (04:42), and adaptive (06:26) systems. Conversely, with moderate learning, the mixed-initiative system was faster, followed by the adaptable, adaptive, and static systems. On average, the time spent learning difficult vocabulary tasks was with the adaptable system, then the adaptive system, and last with the static system. When learning antonyms, using the adaptive system was best, then the adaptable (user approach and decision), system, and last the mixed-initiative system. When learning synonyms, the adaptive (system approach and decision), system was best, then the mixed-initiative system, and last the adaptable system.

5.11.5 System Effectiveness Analysis

To examine and evaluate the effectiveness of the three systems, additional vocabulary online learning approaches were used. The NHs is identified as shown in **Table 34**.

Table 34 : Test of null hypotheses for effectiveness

	NH1 There is no difference in the means of effective time to retain vocabularies between static and adaptable groups.	
	Statement	Null hypotheses
A1	Learning easy vocabularies effectively with the systems	*NH1.1 There is no difference between the means of easy learning vocabularies with static and adaptable systems between the groups*
A2	Learning moderate vocabularies effectively with the systems	*NH1.2 There is no difference between the means of moderate learning vocabularies with static and adaptable systems between the groups*
A3	Learning difficult vocabularies effectively with the systems	*NH1.3 There is no difference between the means of difficult learning vocabularies with static and adaptable systems between the groups*
A4	Learning meaning & antonyms vocabularies effectively with the systems	*NH1.4 There is no difference between the means of antonyms learning vocabularies with static and adaptable systems between the groups*
A5	Learning meaning & synonymous vocabularies effectively with the systems	*NH1.5 There is no difference between the means of synonymous learning vocabularies with static and adaptable systems between the groups*

5.11.5.1 Effectiveness Test

The t-test was conducted between groups to determine the differences between conditions in the number of subjects who completed all tasks in different groups and tasks that were completed by all subjects in one group. The independent t-test has been conducted to examine the effectiveness of null hypotheses that are shown in **Table 35**, and determines whether the null will be rejected or will fail to reject the hypothesis. **Table 35** shows that all *p*-values were greater than .05 ($p > .05$), which means there were no significant differences between the means of two groups and failure to reject the NH as shown in (**Table 36)**. The assumption of homogeneity of variances was tested and satisfied via Levene's F test (F (32) = 9.49, p = .004). The independent sample t-test was associated with (32) = -0.792, p = 0.434, which was not significant. **Table: 35** listed all assumptions between groups. While the Levene's test was not associated with each condition because of enlarging the results, the tests result for the *p*-value was stated to determine the NH and complete report results.

Table 35: T-test results for tasks completion (statistically sufficient were bolded)

Conditions	**Subjects who completed all tasks**			**Tasks completed by all subjects**		
	Easy & Antonym	**Moderate & Synonym**	**Difficult**	**Easy**	**Moderate**	**Difficult**
Static vs. Adaptable	$t(32)$ = - 0.792 , p = 0 .434	**$t(31)$ = - 4.940, p = 0.001**	**$t(16)$ = -24.256, p =0 .001**	$t(21)$ = 0.854, p = 0.403	**$t(21)$ = 4.299 p = 0.001**	**$t(20)$ = -13.254 p = 0.001**
Static vs. Adaptive	$t(34)$ = 0.487 , p = 0.629	**$t(21)$ = - 4.235, p = 0.001**	**$t(23)$ = -16.901, p = 0.001**	**$t(22)$ = - 4.008, p = 0.001**	**$t(21)$ = -5.902, p = 0.001**	**$t(14)$ = -5.274, p = 0.001**
Adaptable vs. Adaptive	$t(42)$ = 1.314 , p = 0.196	**$t(22)$ = - 3.708, p =0 .001**	**$t(22)$ = - 2.921, p = 0.008**	**$t(23)$ = -3.477, p = 0.002**	**$t(23)$ = - 2.371, p = 0.026**	$t(15)$ = 0.549, p = 0.591
Antonyms vs. Synonyms	***X***	**$t(37)$ = - 2.162, p = 0.037**	**$t(28)$ = - 4.450, p = 0.001**	***X***	$t(22)$ = -0.250, p = 0.805	$t(24)$ = -0.027, p = 0.979

Overall, there were some significant differences in the number of subjects who completed all tasks. For example, in the moderate vocabulary in the adaptable group and the adaptive group conditions (t (22) = - 3.708, p = 0.001), but not significant in the adaptable group and adaptive group in the easy system (t (42) = 1.1314, p = 0.196). **Table 36** shows the percentages of all easy, moderate, and difficult tasks completed by all subjects in the three conditions, as well as the overall percentages. The analysis of variance (ANOVA) test showed a significant difference in numbers of subjects who completed all tasks. The comparison was indicated in all subjects who completed all tasks in critical time, as shown in **Table 36**.

Table 36: Assumption of compared the groups' results

Con	Statement Assumption	Groups	Independent Sample *t*-test	
			df	Sig.
C1	Learning easy vocabularies effectively with the systems	Static	32	0.434
		Adaptable		
C2	Learning moderate vocabularies effectively with the systems	Static	21	**0.001**
		Adaptive		
C3	Learning difficult vocabularies effectively with the systems	Adaptable	22	**0.002**
		Adaptive		
C4	Learning moderate synonymous & antonyms vocabularies effectively with the systems	Antonyms	37	**0.037**
		Synonym		
C5	Learning difficult synonymous & antonyms vocabularies effectively with the systems	Antonyms	28	**0.001**
		Synonym		

The NH was tested and the results were shown with respect to accepting or rejecting it. To determine the effectiveness of its use, a comparison of the systems in their stated condition was made between the two groups. Effectiveness was measured by tasks that were successfully completed by all subjects. The number of tasks correctly completed within the time criterion was a percentage of tasks performed. It was also assumed that the subjects successfully completed all tasks within the criterion time. Terence stated that to evaluate the effectiveness of the system, it must be compared with the definition of effectiveness and the criterion for evaluating and comparing [272]. The advantage of using criteria is to ensure system reliability and to understand mean-time-between-failure); this is needed because of the lack of standardised usability measures, which led to the actual criteria [272]. The actual criterion is useful and repeatable to ensure measures that include these characteristics: a) a solid definition and understanding, b) a metric to compute from raw usability data, c) a standard way to measure and take data, and d) levels of performance that can be scored to indicate goodness. The task criterion time was determined prior to the experiment through a pilot study; the design tasks led to an increased level of vocabulary complexity in three levels of learning interaction (see **Table: 37**).

Hypothesis statements	Result
NH1 There was no difference between the means of effective time to retain easy vocabularies between static and adaptable groups.	Rejected
NH1.1 There was no difference between the means of easy learning vocabularies with static and adaptable systems between the groups.	Accepted
NH1.2 There was no difference between the means of moderate learning vocabularies with static and adaptable systems between the groups.	Rejected
NH1.3 There was no difference between the means of difficult learning vocabularies with static and adaptable systems between the groups.	Rejected
NH1.4 There was no difference between the means of antonyms learning vocabularies with static and adaptable systems between the groups.	Rejected
NH1.5 There was no difference between the means of synonymous learning vocabularies with adaptable and adaptive systems between the groups.	Rejected

Table 37: The Null hypothesis test results for effectiveness

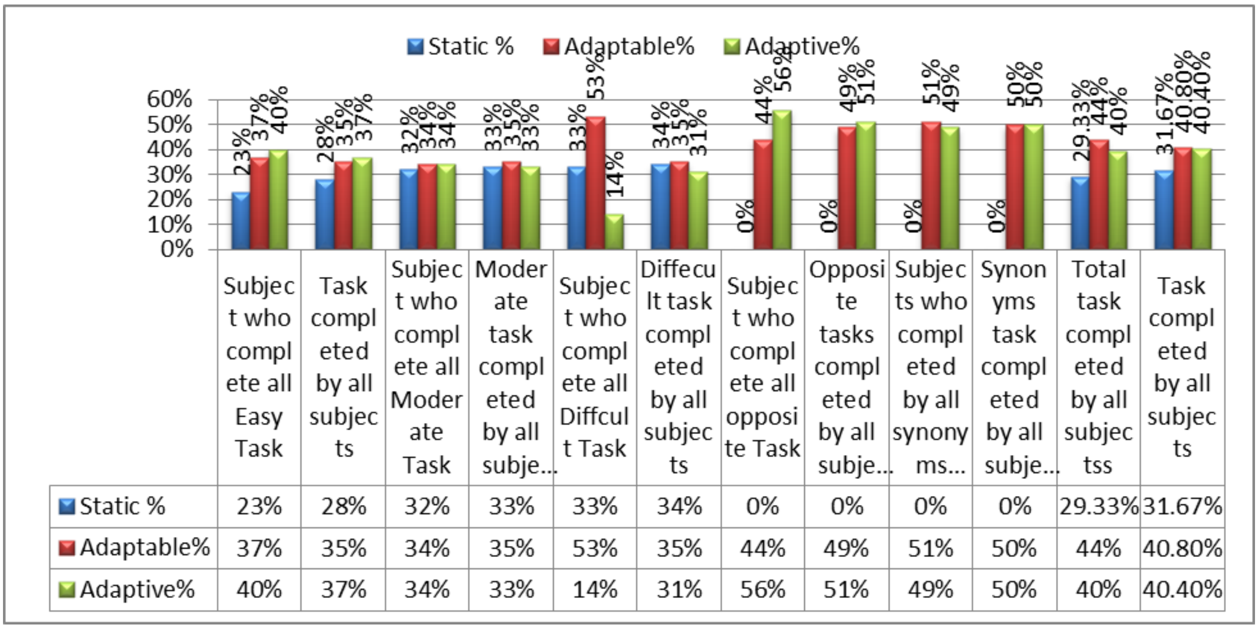

Figure 14: Effectiveness comparison between subjects and tasks performed in the three approaches

Overall, there were some significant differences in the number of subjects who completed all tasks. **Figure 14** shows the difference between the interactive systems as well as the difference in synonyms and antonyms platforms. The percentage of easy, moderate, and difficult tasks completed under the three conditions is in addition to the synonyms and antonyms learning tasks. The ANOVA test showed a significant difference in the number of subjects who completed the tasks. A t-test was used to determine the diversity between the conditions. Table 28 shows t-test results indicating a significant difference at 0.05 between the numbers of tasks completed by all subjects.

5.12 Introduction to the Mixed-Initiative Approach

Mixed-initiative (mixed between system and user approaches) is an automated mix of platform action systems and a result of user control to user needs, which is an important interaction aspect of effective learning to solve problems and perform tasks; moreover, mixed-initiative (mixed between system and user approaches) refers to a flexible interaction strategy for best time and action[273]. The goal of the iterative system is to determine the interaction path of the learning strategy for difficult words to assist with learning goals. J.Lester, 1999 was developed computational models of mixed-initiative, which monitored a user's progress and provided a manner of contribution to help achieve the twin goals of learning effectiveness and effectively [274]. The mixed-initiative (mixed between system and user approaches) approach was provided a personalised Web content and GUI to maintain good decision-making in learning. Decision control was making distinguishing between adaptivity and adaptability approaches with measuring usability (effectiveness and efficiency) of system use. To achieve a mixed level the experimental was carried out with 24 subjects and the results were compared with the adaptive and adaptable approaches. The aim was to compare the usability of the learning achievement with regard to task completion.

5.12.1 Mixed-Initiative Platform

Mixed-initiative (mixed between system and user approaches) technique in this thesis was controlled with shared between the time it takes to learn the words and fewer mistakes occurred to it and less jump; the direct involvement of the user was prevented in this case, but all vocabulary time accounting was used in the mixed-initiative approach to ensure the way of learning and timely managed with fewer mistakes. The mixed-initiate (mixed between system and user approaches) algorithm was dynamically determined based on the timely measured and predetermined correctness and jump of each word.

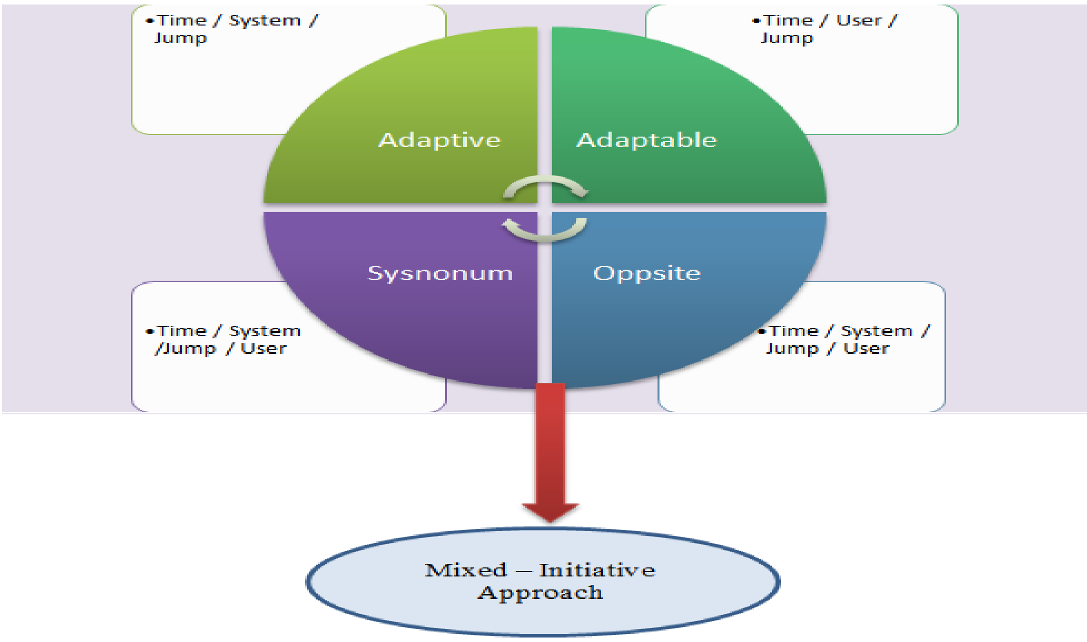

Figure 15: Mixed-initiative scenarios approach diagram

Figure: 15 show four accompanying conditions of tasks for performing task-learning vocabulary: two approaches and two conditions of learning. Mixed-initiative accompanying four areas of learning; decision-making then depends on the final result of the accompanying. The aim was to understand the subject’s vocabulary retention under the mixed-initiative condition and how the results were achieved.

5.12.2 Problems and Solutions

It is important to explore the new technology to discover suitable solutions for these problems and to look for new innovations; learning furthers our knowledge and that of future generations with the expansion of computers and Internet. There may be a day when mothers can observe their babies in the womb via computers, and action of teaching and learning might commenced from this point. The complexity of learning and the difficulty of memorising difficult vocabularies increase the demand to discover new approaches to overcome this complexity. To overcome the difficulty of learning vocabularies, especially complex ones, the help of synonyms, antonyms, or alternative methods give the learner a chance to retain the word from different angles.

5.12.3 Experimental Hypotheses

The aim of this experiment was to measure the efficiency and the effectiveness of the mixed-initiative approach and to compare it with the other approaches.

The hypotheses related to efficiency are:

H1: The mixed-initiative (mixed between system and user approaches), online learning approach is more efficient in assisting online learning vocabulary than the static online learning approach.

H1-1: The mixed-initiative (mixed between system and user approaches), online learning approach is more efficient in assisting in the learning of easy vocabularies than the static online learning approach.

H1-2: The mixed-initiative (mixed between system and user approaches), online learning approach is more efficient in assisting with the learning of moderate vocabularies than the static online learning approach.

H1-3: The mixed-initiative (mixed between system and user approaches), online learning approach is more efficient in assisting with the learning of difficult vocabularies than the static online learning approach.

The hypotheses related to effectiveness are:

H4: The mixed-initiative (mixed between system and user approaches); approaches will be more effective than the adaptable approach in terms of completely gaining vocabularies successfully.

H4-1: The mixed-initiative (mixed between system and user approaches), online learning approach will be more effective than the static online learning approach in terms of completely gaining adaptable vocabularies successfully.

H4-2: The mixed-initiative (mixed between system and user approaches); online learning approach will be more effective than the static online learning approach in terms of completely gaining moderate vocabularies successfully.

H4-3: The mixed-initiative (mixed between system and user approaches); online learning approach is more effective than the static online learning approach in terms of completely gaining difficult vocabularies successfully.

H5: The mixed-initiative online learning approaches will be more effective than the adaptable online learning approach in terms of completely gaining vocabularies successfully.

H5-1: The mixed-initiative (mixed between system and user approaches); online learning approaches will be more effective than the adaptable online learning approach in terms of completely gaining easy vocabularies successfully.

H5-2: The mixed-initiative online learning approaches will be more effective than the adaptable online learning approach in terms of completely gaining moderate vocabularies successfully.

H5-3: The mixed-initiative (mixed between system and user approaches); online learning approaches will be more effective than the adaptable online learning approaches in terms of completely gaining difficult vocabularies successfully.

H6: The adaptive (system approach and decision) and mixed-initiative (mixed between system and user approaches); online learning approaches will be more choice than the static online learning approach.

H7: The achievement test results for the adaptive (system approach and decision), online learning approach users will differ from those in adaptable (user approach and decision) and static online learning approaches.

To analyse the results, descriptive and inferential statistics will be used. Descriptive statistics will be used to describe, compare, and relate variables. Inferential statistics will be used to estimate the parameter(s) and testing of statistical hypothesis so that inferential statistics will apply the logic of the hypothesis tested to examine the statistical significance between variables, and conventionally the 5% level of significance ($p = 0.05$).

5.12.4 Experimental Methods

The hypothesis listed above was tested empirically using within-subjects (or within-participants) design to allow the user to compare group interactions and rank the preferred one to measure usability metrics, efficiency, and effectiveness. Between-subjects design was allowed for measuring user satisfaction in online learning vocabularies. The reason for this design, regardless of its advantages, is to avoid any dropout rates or biases that may accrue while using within-subject design, which will lead to a “blank slate” reaction. The selected words consisted of 40 vocabularies, randomly consisting of easy, moderate, and hard words. Each one was timed and the all sessions were measured as soon as the user was assigned to the system. A pilot study vocabulary of 40 words was determined for appropriate size after interviewing users and became unhappy with 50 words during pilot testing. The designed was used between-subject and this method has a disadvantage of slow and learning affects has been controlled.

The hypothesis listed above was tested empirically using between-subjects design and was intended to fit into a vocabulary-learning session. The reason for this design to avoid any dropout rates and biases that may occur while using within-subject design; this will lead to a “blank slate” reaction. Vocabularies consisted of 40 words, randomly consisting of easy, moderate, and hard words. Vocabulary was timely measured during testing in all sessions. During the pilot test, vocabulary words were reduced from 50 to 40 to prevent users from becoming unhappy with the time testing.

5.12.5 Procedure

Subjects and vocabulary were randomly assigned. A questionnaire was then used to obtain demographical, educational, and computer experience information. During this experiment all groups were assigned with a 40-items vocabulary. The task started as soon as the subject completed the first questionnaires; the learning task was considered completed when the student moved to the exam task. A student has a free time go back at any time and an opportunity of free learning and memorising. During the exam time the same procedure applies.

5.12.6 Subjects

The 24 subjects from the Arabic sampling represent the population. Subjects were undergraduate and graduate students from Durham, DMU, and KSA universities. The subjects were a mixed of males and females. The researchers decided to stay in contact to measure most conditions of the experiments. The subjects were chosen as suggested by Rigas, Alsuraihi, and Nelson in other relevant studies. The static online learning approach was used for direct learning of vocabulary and one word meaning, and the vocabulary levels from easy to difficult were collected prior to building the system. The adaptation systems used three levels of vocabulary—easy, moderate, and difficult—from user collection and errors have been collected, but measurements were not analysed because of a time shortage. In addition, time was measured for each vocabulary word within task criterion time, which was measured and designed during the pilot study.

5.12.6 Test Results and Comparisons

To examine and evaluate the efficiency of the three systems time and error were measured, in each vocabulary online learning approaches. The NHs are identified and stated as shown below.

To analyse and evaluate the system efficiency, Q1 was a mixed-initiative online learning approach that was more efficient in assisting online learning vocabulary than the static, antonyms, and synonymous online learning approach. The question was divided into five statements and given to three different groups of users recruited to test different systems. To measure static system efficiency a Task accomplishment time was measured during task completion. Q1 asked if the mixed-initiative online learning approach was more efficient in assisting learning easy vocabularies than the static online learning approach. **Table 35** shows the statements that evaluate efficiency. To analyse this question, null hypotheses were formulated according to the questionnaire.

Table 35: Statements of Q1 null hypotheses (efficiency groups)

	NH1 There is no difference between the means of efficient time to retain vocabularies between mixed-initiative and static groups.	
	Statement	Null hypotheses
A1	Static easy online learning approach vocabularies was more efficient than mixed- initiative approach	*NH1.1 There was no difference between the means of easy learning vocabularies with mixed-initiative and static approach between the groups*
A2	Static moderate online learning approach vocabularies was more efficient than mixed- initiative approach	*NH1.2 There was no difference between the means of moderate learning vocabularies with mixed-initiative and static approach between the groups*
A3	Static difficult online learning approach vocabularies was more efficient than mixed- initiative approach	*NH1.3 There was no difference between the means of difficult learning vocabularies with mixed-initiative and static approach between the groups*
A4	online learning meaning static approach vocabularies were more efficient than antonyms were in mixed-initiative approach	*NH1.4 There was no difference between the means of antonyms learning vocabularies with mixed-initiative and static leaning approach between the groups*
A5	online learning meaning static approach vocabularies were more efficient than synonymous vocabularies in mixed- initiative approach	*NH1.5 There was no difference between the means of synonymous learning vocabularies with mixed-initiative and static meaning approach between the groups*

5.12.7 Normality Distribution Test

Normality tests indicated that learning time was not normally distributed; consequently, non-parametric test (in particular, the Mann-Whitney U test) were used to determine if the mean times were significantly different for easy vocabularies across the two conditions. The results indicate that there was a significant different between the static online learning approach, the mixed-initiative approach, and the static online learning approach for easy vocabularies [p = 0.001> [0.05)]. For easy online learning vocabulary comparison groups, the typical mean rank of the static group was 28.79 and the typical mean rank of the mixed-initiative group was 20.21. Therefore, the Mann-Whitney U score was 185 and the significance associated with the p-value was 0.034, which is less than 0.05, so that the NH will be rejected. This means that mixed-initiative online learning was more efficient in assisting in learning than was the static group (see **Table 38**).

Table 38: The mean rank of static and mixed-intuitive in easy online learning group

Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	*p*-value
Static	24	28.79	691	185	0.034
Mixed-initiative	24	20.21	485		

In normality tests for moderate vocabulary online learning comparison groups for *p*-value [*p*=0.001> [0.05)], the typical rank of the static group was 25.71 and the typical rank of the mixed-initiative group was 23.29. Therefore, the Mann-Whitney U score was 259, the significance associate with the *p*-value was 0.550, which is more than 0.05, so the NH fails to be rejected. This means there were no significant difference between the static and mixed-initiative online learning groups (see **Table: 39**).

Table 39: The mean rank of static and mixed-initiative in the moderate online learning group

Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	*p*-value
Static	24	25.71	617	259	0.550
Mixed-initiative	24	23.29	559		

In normality tests for difficult vocabulary online learning compassion groups for [*p*=0.001> [0.05)], the typical rank of the static group was 33.71 and the typical rank of the mixed-initiative group was 15.29. Therefore, the Mann-Whitney U score was 67 and the significance associated with the *p*-value was 0.001, which is less than 0.05, so that the NH will be rejected. This means the mixed-initiative online learning group is more efficient in assessing than the static online learning group (see **Table 40**)

Table 40: The mean rank of static and the mixed-initiative in difficult online learning groups

Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	*p*-value
Static	24	33.71	809	67	0.001
Mixed-initiative	24	15.29	367		

Table 41: The null statements of all test results for static and mixed-initiative groups

Null hypotheses	Result
NH1 There is no difference between the means of the static online learning approach and the mixed-initiate online learning approach in assisting in the learning of vocabularies between two student groups.	Rejected
NH1.1 There is no difference between the means of the static online learning approach and the mixed-initiative online learning approach in assisting in the learning of easy vocabularies between two student groups.	Rejected
NH1.2 There is no difference between the means of the static online learning approach and the mixed-initiative online learning approach in assisting in the learning of moderate vocabularies between two student groups.	Failed to Reject
NH1.3 There is no difference between the means of the static online learning approach and the mixed-initiative online learning approach in assisting in the learning of difficult vocabularies between two student groups.	Rejected

5.12.8 System Effectiveness Analysis of Mixed-Initiative with Comparison with Static and Adaptive Approaches

Analysing mixed-initiative approach for effectiveness measure was to be formulated with a comparison to other approaches, therefore evaluating effectiveness of mixed-initiative with compared with three vocabulary approaches of online learning. The NHs set off and identified as shown in (see **Table 42)**.

Table 42: NH for effectiveness results

	NH1 There is no difference between the means of effective time to retain vocabularies between mixed-initiative and adaptable groups.	
	Statement	Null hypotheses
A1	Learning easy vocabularies effectively with the systems	*NH1.1 There is no difference between the means of easy learning vocabularies with mixed-initiative and adaptable systems between the groups*
A2	Learning moderate vocabularies effectively with the systems	*NH1.2 There is no difference between the means of moderate learning vocabularies with mixed-initiative and adaptable systems between the groups*
A3	Learning difficult vocabularies effectively with the systems	*NH1.3 There is no difference between the means of difficult learning vocabularies with mixed-initiative and adaptable systems between the groups*
A4	Learning meaning & antonyms vocabularies effectively with	*NH1.4 There is no difference between the means of antonyms learning vocabularies with mixed-initiative and adaptable systems between the*

	the systems	*groups*
A5	Learning meaning & synonymous vocabularies effectively with the systems	*NH1.5 There is no difference between the means of synonymous learning vocabularies with mixed-initiative and adaptable systems between the groups*

5.12.9 Mixed-Initiative Effectiveness Test

A *t*-test was conducted between group conditions to determine difference in conditions with the number of subjects who completed all tasks in different groups and tasks completed by all subjects in the group. Independent *t*-tests were also conducted to examine the effectiveness of the NHs and to determine whether or not the NHs would be rejected. **Table 43** shows that all *p*-values were greater than 0.05 ($p>0.05$), which means there were no significant differences between the means of the two groups and the failure to reject the NH. The assumption of homogeneity of variances was tested and satisfied via Levene's F test, F (32) = 5.071, p = 0.001. **Table 43** lists all the assumptions between groups. While the Levene's test was not associated with each condition because of the increment of results, test result for *p*-value was conducted to determine the NH and the complete report results were shown.

Table 43: T-test results for task completion (statistically were bold)

Conditions	Subjects who completed all tasks			Tasks completed by all subjects		
	Easy	Moderate & Antonyms	Difficult & Synonyms	Easy	Moderate	Difficult
Static vs. Mixed-initiative	***t*(33) = - 2.333 , *p* = 0 .026**	***t*(31) = 5.071, *p* = 0.001**	***t*(32) = 8.569, *p* = 0 .001**	*t*(21) = 0.854, *p* = 0.403	***t*(21) = 4.299 *p* = 0.001**	***t*(20) = -13.254 *p* = 0.001**
Adaptable vs. Mixed-initiative	*t*(31) = -1.462 , *p* = 0.154	*t*(30) = - 1.449, *p* = 0.158	***t*(29) = -2.066, *p* = 0.048**	***t*(22) = - 4.008, *p* = 0.001**	***t*(21) = -5.902, *p* = 0.001**	***t*(14) = -5.274, *p* = 0.001**
Adaptive vs.	***t*(30) =**	*t*(38) = 0.701,	***t*(33) =**	***t*(23) =**	***t*(23) =**	*t*(15) =

Mixed-initiative	**-2.315 , *p* = 0.028**	*p* = 0 .487	**- 4.943, *p* = 0.001**	**-3.477, *p* = 0.002**	**- 2.371, *p* = 0.026**	0.549, *p* = 0.591
Antonyms	***X***	***t*(37) = - 2.872, *p* = 0.007**	***t*(33) = -4.348, *p* = 0.001**	***X***	*t*(22) = -0.250, *p* = 0.805	*t*(24) = -0.027, *p* = 0.979
Synonym	***X***	***t*(33)= -9.184, *p* = 0.001**	***t*(32)= - 8.301, *p* = 0.001**	***X***	*t*(28) = - 1.800, *p* = 0.83	*t*(29) = - 1.128, *p* = 0.256

When comparing static platform with the mixed-initiative, there were some significant in results between all subjects who completed all tasks. While using the adaptable platform, there were no significance in learning easy and moderate vocabularies, but there was in the adaptable difficult learning condition. Example of moderate adaptable group condition with mixed-intuitive group condition with subjects who completed all tasks, were as follow (t (30) = - .449, p = 0.158, but there was significant easy adaptive group and mixed-initiative (t (30) = -2.315, p = 0.028). Table 42 shows the percentages of all easy, moderate, and difficult tasks completed by all subjects in three conditions, as well as overall percentages. ANOVA tests showed a significant difference in numbers of subjects who completed all tasks. The compression was indicated when all subjects completed all tasks in critical time, as shown in Table 44.

Table 44: T-test comparison results between two groups and the significate in subjects who completed all tasks within criterion time.

Con	Statement Assumption	Groups	Independent Sample t-test	
			df	Sig.
C1	Learning easy vocabularies effectively with the systems	Static Mixed-initiative	33	**0.026**
C2	Learning moderate vocabularies effectively with the systems	Adaptable Mixed-initiative	30	0.158
C3	Learning difficult vocabularies effectively with the systems	Adaptive Mixed-initiative	33	**0.001**
C4	Learning moderate synonymous vo-	Adaptive	32	**0.001**

	cabularies effectively with the systems	Mixed-initiative		
C5	Learning difficult antonyms vocabularies effectively with the systems	Adaptable	37	**0.007**
		Mixed-initiative		

The NH was tested and the results are show in **Table 45** regarding whether to accept or reject the NHs. To determine the effectiveness of use, a comparison is shown between two groups of systems in determined condition. Effectiveness was measured by all subjects who completed all tasks successfully and within their criterion times as a percentage of tasks performed. More subjects completed easy, moderate, and difficult vocabulary tasks using the mixed-initiative approach more than the other three approaches, while systematic uses of antonyms and synonyms were more preferable compared to the other platforms. In addition, the mean average percentage was higher in the mixed-initiative approach in both antonyms and synonym platforms. The static approach was compared and excluded from antonyms and synonym conditions due to the lack interactivity technique.

Table 45: NH test results

Hypothesis statements	Result
NH1 There was no difference between the means of effective time to retain easy vocabularies between static and mixed-initiative groups.	Rejected
NH1.1 There was no difference between the means of easy learning vocabularies with static and mixed- initiative approach between the groups.	Rejected
NH1.2 There was no difference between the means of moderate learning vocabularies with adaptable and mixed-intuitive approach between the groups.	Fail to reject
NH1.3 There was no difference between the means of difficult learning vocabularies with adaptive and mixed- initiative approach between the groups.	Rejected
NH1.4 There was no difference between the means of antonyms learning vocabularies with adaptable and mixed- initiative approach between the groups.	Rejected
NH1.5 There was no difference between the means of synonymous learning vocabularies with adaptive and mixed- initiative approach between the groups.	Rejected

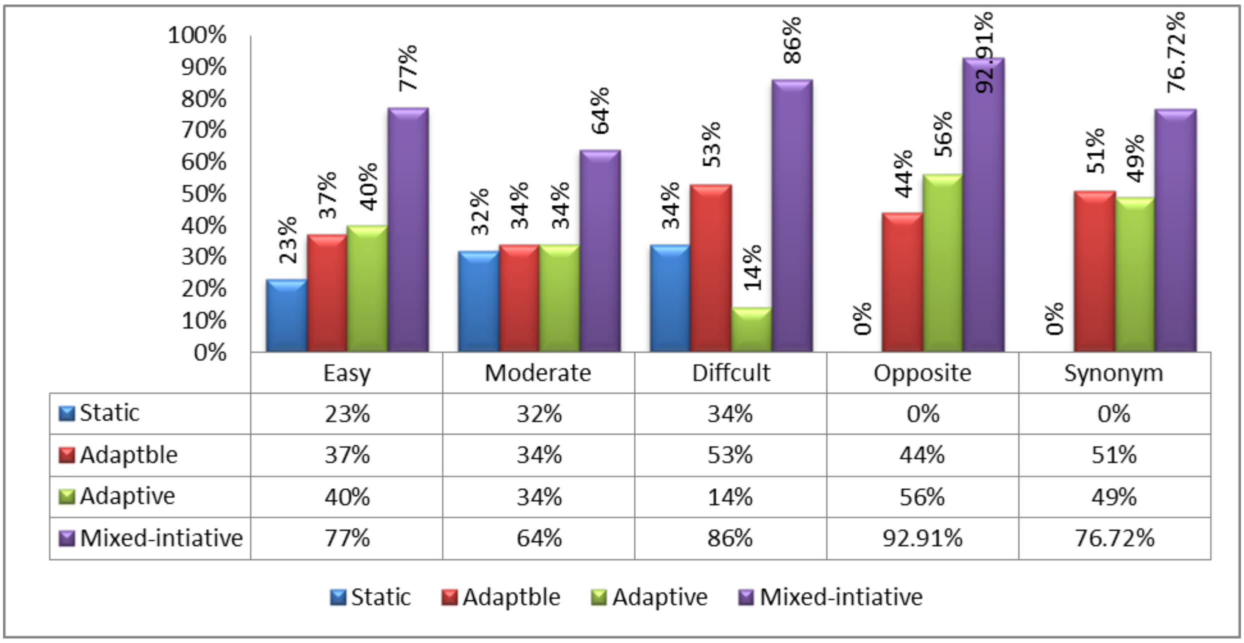

Figure 16: The NH test results for mixed-initiative approach

Figure 16 shows the mean average value of the percentage of overall task completion in four platforms. Overall, the mixed-initiative platform as compared to all systems has the highest average value of all systems; respectively, easy vocabulary has an average of 77%, moderate 64%, and difficult 86%, whereas the lowest was 14% in adaptive systems. Faulkner and Frekjmr stated that effectiveness can be measured in terms of whether gaols are met or tasks are completed successfully within a certain time [262, 263]. To achieve the objective of the research successfully, the percentage of the effectiveness has been compared in the four approaches, and mixed-initiative has the highest average percentage of the overall tasks achieved (see **Figure 17**).

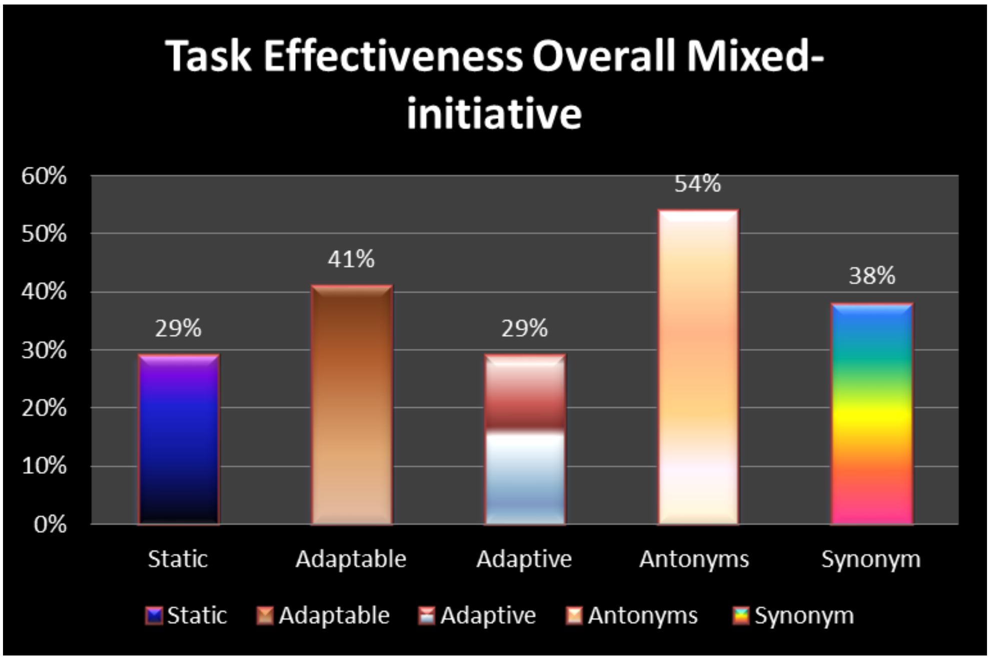

Figure 17: The percentage of subjects who completed all tasks successfully

Mixed-initiative is a technique of comparing all three platforms to best meet the user's needs. **Figure 17** shows the effect of each technique performed using the mix-initiative technique. In other words, the percentage of each component that has an effect in the mixed-initiative approach (e.g., static and adaptive) was used equally in the mixed-initiative platform, while the antonyms technique was the tightest with 54% of the approaches. During the performance of the mixed-initiative execution task, the system usage of each condition needed to be performed.

5.13 Knowledge and Achievements

Data were collected from the test results obtained after completion of the study session. Some studies emphasised that the role of multimedia in interfaces for online learning illustrates the way in which knowledge is measured based on post-experimental questions distributed to the learner [275]. Conversely, measuring a student's capabilities, perception, and performance for assisting the effect of interaction on the learning process, multimedia online learning approach was the approach was recommended to be used learning [276]. Online learning stated that the use of achievement tests to evaluate the user's comprehension or knowledge is based on recall and recognition and is by usability evaluation [259]. An achievement test was administered to assess the level of user knowledge and understanding with a multiple-choice test, wherein students were required to select a correct answer for each vocabulary item [277].

5.13.1 Aims

The empirical study and its investigation will point out the four approaches and illustrate the complete idea of a better platform for the best learner achievement with assistance of usability. The main purpose of this testing was to compare the results of learner achievement between these four platforms to help designers, usability learner and researchers.

5.13.2 Objectives

The investigation was carried out empirically by involving a number of N=24 subjects in each experiment and testing their knowledge of learning vocabularies and the test was set and consist of randomised of five answers for each vocabulary item with one correct answer to measure student knowledge.

5.13.3 User's knowledge and Evaluation

Alotaibi stated that knowledge is important to be recognised, and vague and hard to be grasped, and related to many factors, such as different areas need to be covered, levels, principles, taxonomies, strategies, and trends [259]. Knowledge in this study is to be considered from two direction: First direction is perspective, which is described as human (dynamic) and nonhuman (static) [259]. Knowledge can be recognisable by data transfer, but there is a vital difference in this data transformation. This concept was discussed by T.Davnport and L.Prusak , who stated that data is a structured set of isolated raw assertions without development of context, intent, or meaning, but transformation is information presented in useful and ways with contexts and meanings [278]. Gathering information about users was important, because this supply of information about user to help representing for user's need. The target of this study is to improve and increase students' language. **Figure 18** shows the mean value of tests achieved in four platforms; the static platform had a higher level of results than the other platforms.

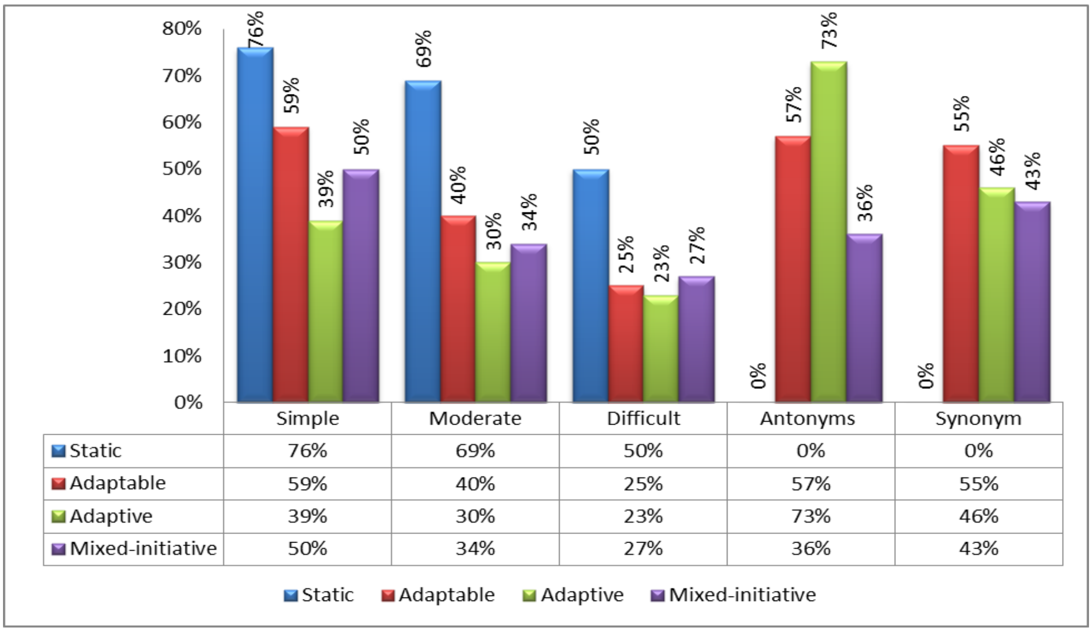

Figure 18: Results of test achievement

5.14 User Satisfaction by SUS and Analysis

There were 99 subjects from the Arabic population (39 female and 60 male) to complete Study 1, which was about the SUS survey. They were divided into three independent groups of 33 each to perform the empirical study. They were divided equally because of the number of students who managed to perform the study. This was also after the decision was made for the sample size to consist of 32 subjects. Internet experimental was monitored and controlled. The subjects performed the same tasks and the vocabularies were randomly picked by the system, but it was controlled by difficulty levels (easy, medium, and difficult). There was no training needed for these experiments because the tasks were forward, clear, and direct. Static and adaptable approaches had 20 easy vocabularies, 10 moderate, and 10 difficult. The adaptive system was sensitive system for the difficulty words level and interchangeable words sometimes from 20 vocabularies and 10. All subjects were between the ages of 18 and 40; 24.2% were in college, 12.1% were in high school, 51.5% were post-graduate students, and 12.1% were college students. With regard to Internet usage, approximately 3% were new to the Internet, 12.1% had three years' experience, 24.2% had 6 years' experience, and 60.6% had more than 10 years' experience. With respect to changing software settings, 12.1% said they never did, 9.1% did every time, and 15.2% did when there was a problem. For the whole sample, the majority of participants (42, or 63.6%) said they had changed software settings if necessary. Eight participants (12.1%) had never changed software settings. Six participants (9.1%) had changed the software settings each time they used new software and 10 participants (15.2%) had changed software when they received errors.

5.15 Experimental Design

The hypotheses listed above were tested empirically using a between-subjects design (i.e., each subject participated in only one condition of learning) (see **Figure 10**).

This design was considered ideal for Study 1 because each learning condition was designed to last approximately 2 hours; there would have been a significant learning effect if a within-subject design had been used. Each subject was assigned randomly.

5.16 Procedure

Tasks were designed to fit the learning session. Time sets depending on criterion time that determined through-pilot study for appropriate time. The experimental procedure was as follows: (1) Before the experiment, a personal survey was used to obtain information on subjects' demographic factors and on their computer experience; (2) Subjects had learning sessions for one vocabulary item at a time with open time for memorisation; (3) Exam sessions were commenced with every vocabulary with five randomised vocabulary meanings one was correct and five were incorrect: (4) At the end of the exam questions, subjects were asked to answer 12 SUS statements for data collection; and (5) Behind the scenes, all data for usability metrics were collected for completed usability measures for all four systems. The adaptable system was user's user control to customise learning chose to learn from two choices between learning by synonyms or antonyms.

5.17 Data Collection

This section was intended to data collection were important part of the main experiment study. The data had been collected, evaluated, and separated in two sections. The first section was related to system usability attributes concerning effectiveness and efficiency. The second section was related to user satisfaction evaluated through SUS. The objective for separating the experiment into two sections was to allow comparison between platforms. Each section was recorded and designed properly to get an accurate result, which helped to measure the time taken to perform mail learning tasks and the number of errors that occurred, which was automatically calculated. Meanwhile, user satisfaction was to be evaluated through SUS. In addition, it precisely calculated the time it took to customise learning time and the frequency of clicks on the 'recently' and 'frequently' options in every platform.

Experiments were recorded by the database and record logs to provide detailed data on subjects' performance and to document any errors that occurred. It also allowed precise calculations of task completion times. Subjects were no reward for the experiments, to ensure that they would be performed smoothly and without any distraction.

5.18 Measurement

To fulfil the aim of the study, three objectives had to be attained. The first was to measure the efficiency of each condition precisely by timing the completion of tasks and counting the number of clicks, vocabulary time tasks, and errors in each learning condition. The second objective was to measure the effectiveness of each condition by calculating the percentage of tasks completed successfully by all subjects and the number of subjects who successfully completed all tasks. The third objective was to obtain the subjects' assessments of ease of use and to learn with their own overall satisfaction.

The term "efficiency" can be identified and measured in terms of the effort required to accomplish a goal or task [262, 263]. Here, it was measured by the time taken to complete tasks, the number of mouse clicks and learning effort necessary in memorising vocabulary, and the number of errors made in doing each task. Effectiveness can be measured in terms of whether goals are met or tasks are completed successfully [262, 263]. Here, it was calculated as the percentage of subjects who completed tasks and as the percentage of tasks completed by all subjects. To compare effectiveness across the three session conditions, a critical time for task completion was derived for each level of difficulty (easy, midrate, and complex vocabularies). Thus, a task would be regarded as successfully completed if subjects finished it within the critical time or average level of vocabulary time. The metrics and DVs are set out in **Table 46**.

Table 46: Metrics and DV

Metrics	DV
Efficiency	1. Time taken to complete the tasks 2. Number of mouse clicks 3. Number of errors; the rate is to convert the proportion based on the opportunity for errors
Effectiveness	1. Percentage of tasks successfully completed 2. Number of subjects who successfully completed all tasks
Achievement	Evaluate the level of learning's knowledge.

Section 1: This section considers the experimental results obtained from quantitative measures of self-reported and observed data. In addition, interviews were conducted with subjects during pilot tests. The data collected and analysed was as follows:

Twenty-four subjects were assigned for testing each system for interaction. The experiment designed was following within-subject design experiment. This design was used because its fundamental advantages were power results and reduction in error variance associated with individual differences (**section 4.14 sampling size**) for more detail. For this test, 120 vocabulary items in total were selected and the vocabulary was classified as easy (40 words), moderate (40 words), and difficult (40 words) to learn. Each student learned the 40 easy vocabularies using the static system, the 40 moderate vocabularies using the adaptable system, and the 40 difficult words using the adaptive system. The words, their complexity, and the system used are shown in Appendix F for more detail. The ISO defines usability as the effectiveness, efficiency, and satisfaction with which specified users can achieve specified goals in particular environments [37]. The objective of this research was to measure the effectiveness of each learning task by calculating the percentage of tasks completed successfully by all subjects and the number of subjects whom successfully completed all tasks. Effectiveness can be measured in terms of whether goals are met or tasks are completed successfully [263]. Therefore, to compare effectiveness across the three conditions, a critical time for completion was derived for each word's level of difficulty (easy, moderate, and difficult). Thus, a task would be regarded as successfully completed if subjects finished within the critical time. The length of time it took the students to learn each word and to complete the examination were measured. During the learning and examination times, the number of errors that the students made was recorded.

5.18.1 Learning Time for Easy Vocabularies Using the Static System

The students were allowed to use the static system to learn 40 easy words. Summary statistics for each student are shown in **Table 47**. For example, student 1 took an average of 4.72 seconds to learn an easy word (median=4.57s). Minimum learning time for one word for student 1 was 2.17s and the maximum learning time was 9.05s. For student 2, the corresponding figures are average = 4.66, median = 3.98, minimum = 1.15 and maximum = 14.17. The rest of the students' times are shown in the table. Overall, the students took 5.02s to learn an easy word (median = 4.27s); the minimum time to learn an easy word was 1.15s; and the maximum time was 14.17s.

Table 47: Summary statistics of subjects using static system to learn easy words

Student	Number of Words	Mean	Median	Std. Deviation	Minimum	Maximum	Percentiles 25th (Lower Quarter)	50th (Median)	75th (Upper Quarter)
1	40	4.72	4.57	1.49	2.17	9.05	3.60	4.57	5.37
2	40	4.66	3.98	3.13	1.15	14.17	3.17	3.98	4.28
3	40	3.96	3.28	2.50	2.02	14.17	2.60	3.28	4.17
4	40	4.46	4.05	2.72	2.02	14.17	2.75	4.05	5.03
5	40	4.13	3.28	2.47	2.02	13.28	2.73	3.28	4.27
6	40	5.75	3.67	4.53	2.02	14.17	2.74	3.67	9.44
7	40	4.72	4.05	3.15	2.02	14.17	2.64	4.05	5.07
8	40	5.19	4.05	3.85	2.02	14.17	2.64	4.05	5.13
9	40	5.15	4.05	3.81	2.02	14.17	3.17	4.05	4.83
10	40	5.24	3.67	4.03	2.02	14.17	2.60	3.67	4.83
11	40	5.98	4.05	4.67	2.02	14.17	2.60	4.05	12.50
12	40	6.17	4.06	4.74	2.02	14.17	2.71	4.06	13.28
13	40	5.48	5.12	2.88	2.08	13.28	3.19	5.12	6.28
14	40	4.87	4.21	2.62	2.25	13.28	3.20	4.21	5.28
15	40	4.73	4.29	2.26	2.08	12.10	3.07	4.29	6.05
16	40	5.48	5.12	2.88	2.08	13.28	3.19	5.12	6.28
17	40	5.00	4.24	2.63	2.25	13.28	3.33	4.24	5.50
18	40	4.73	4.29	2.26	2.08	12.10	3.07	4.29	6.05
19	40	5.48	5.12	2.88	2.08	13.28	3.19	5.12	6.28
20	40	4.90	4.21	2.63	2.25	13.28	3.20	4.21	5.49
21	40	4.73	4.29	2.26	2.08	12.10	3.07	4.29	6.05
22	40	5.41	5.12	2.71	2.08	13.07	3.19	5.12	6.28
23	40	4.87	4.21	2.62	2.25	13.28	3.20	4.21	5.28
24	40	4.73	4.29	2.26	2.08	12.10	3.07	4.29	6.05
All	960	5.02	4.17	3.12	1.15	14.17	3.17	4.17	5.57

5.18.2 Learning Time for Moderate Words Using the Adaptable System

The students used the adaptable system to learn 40 moderate words. Summary statistics for each student are shown in **Table 48**. For example, student 1 took an average of 9.86 seconds to learn a moderate word (median = 9.22s). Minimum learning time for one word for student 1was 8.02 and the maximum learning time was 16.50s. For student 2, the corresponding figures are average = 9.93, median = 9.88, minimum = 1.15, and maximum = 14.17. The rest of the students' times are shown in the table. Overall, the students took 9.92s to learn moderate words (median=9.60s); the minimum time to learn a moderate word was 1.15s and the maximum time was 16.50s.

Table 48: Summary statistics of subjects using adaptable system to learn moderate words

Student	Number of Words	Mean	Median	Std. Deviation	Minimum	Maximum	Percentiles 25th (Lower Quarter)	Percentiles 50th (Median)	Percentiles 75th (Upper Quarter)
1	40	9.86	9.22	1.61	8.02	16.50	9.15	9.22	10.69
2	40	9.93	9.88	2.57	1.15	14.17	9.18	9.88	10.75
3	40	9.75	9.44	1.06	8.17	14.17	9.17	9.44	10.17
4	40	9.78	9.27	1.39	8.02	14.17	9.15	9.27	10.17
5	40	9.92	9.60	0.89	9.02	13.28	9.17	9.60	10.28
6	40	10.52	9.88	1.79	9.02	14.17	9.19	9.88	10.95
7	40	9.80	9.46	1.41	8.02	14.17	9.15	9.46	10.27
8	40	10.11	9.60	1.67	8.02	14.17	9.17	9.60	10.27
9	40	10.23	9.60	1.76	8.02	14.17	9.17	9.60	10.28
10	40	10.28	9.60	1.69	8.02	14.17	9.19	9.60	10.28
11	40	10.79	9.60	2.00	9.02	14.17	9.27	9.60	13.28
12	40	10.70	9.60	1.92	9.02	14.17	9.27	9.60	13.28
13	40	9.79	9.46	1.29	8.02	13.28	9.14	9.46	10.28
14	40	9.67	9.27	1.16	8.13	13.28	9.17	9.27	10.07
15	40	9.67	9.29	1.06	8.02	12.18	9.14	9.29	10.28
16	40	9.79	9.46	1.29	8.02	13.28	9.14	9.46	10.28
17	40	9.67	9.27	1.16	8.13	13.28	9.17	9.27	10.07
18	40	9.67	9.29	1.06	8.02	12.18	9.14	9.29	10.28
19	40	9.79	9.46	1.29	8.02	13.28	9.14	9.46	10.28
20	40	9.67	9.27	1.16	8.13	13.28	9.17	9.27	10.07
21	40	9.67	9.29	1.06	8.02	12.18	9.14	9.29	10.28
22	40	9.79	9.46	1.29	8.02	13.28	9.14	9.46	10.28
23	40	9.67	9.27	1.16	8.13	13.28	9.17	9.27	10.07
24	40	9.67	9.29	1.06	8.02	12.18	9.14	9.29	10.28
Total	960	9.92	9.60	1.48	1.15	16.50	9.17	9.60	10.28

5.18.3 Learning Time for Difficult Words Using the Adaptable System

The students used the adaptive system to learn 40 difficult words. Summary statistics for each student are shown in **Table 49**. For example, student 1 took an average of 12.94 seconds to learn a difficult word (median = 13.19s). The minimum learning time for one word for student 1 was 7.27s and the maximum learning time was 18.95s. For student 2, the corresponding figures are average = 13.28s, median = 13.28s, minimum = 10.50 and maximum = 15.22. The rest of the students' times are shown in the table. Overall, the students took 13.51s to learn difficult words (median

= 13.28s); the minimum time to learn a difficult word was 7.20s and the maximum time was 23.28s.

Table 49: Summary Statistics of subjects using adaptive approaches to learn difficult words.

Student	Number of Words	Mean	Median	Std. Deviation	Minimum	Maximum	Percentiles		
							25th (Lower Quarter)	50th (Median)	75th (Upper Quarter)
1	40	12.94	13.19	2.67	7.27	18.95	10.56	13.19	15.12
2	40	13.28	13.28	1.06	10.50	15.22	12.60	13.28	14.19
3	40	13.63	13.28	1.86	11.02	22.60	12.60	13.28	14.22
4	40	13.73	13.86	1.35	11.23	17.27	12.64	13.86	14.26
5	40	13.40	13.23	1.20	10.78	16.28	12.60	13.23	14.22
6	40	13.72	13.28	2.18	11.28	23.28	12.60	13.28	14.22
7	40	13.46	13.48	1.44	8.17	16.15	12.60	13.48	14.27
8	40	13.22	13.28	1.66	7.27	16.35	12.60	13.28	14.20
9	40	13.57	13.28	0.83	12.02	15.25	13.17	13.28	14.22
10	40	13.51	13.28	0.92	12.02	16.17	12.60	13.28	14.22
11	40	13.34	13.28	0.79	12.02	14.27	12.60	13.28	14.17
12	40	13.43	13.28	0.74	12.02	14.27	12.74	13.28	14.17
13	40	13.28	13.28	2.44	7.20	16.30	12.35	13.28	15.24
14	40	13.65	14.21	1.75	7.83	16.30	12.60	14.21	14.27
15	40	13.80	13.73	1.99	8.02	16.30	12.35	13.73	15.50
16	40	13.28	13.28	2.44	7.20	16.30	12.35	13.28	15.24
17	40	13.65	14.21	1.75	7.83	16.30	12.60	14.21	14.27
18	40	13.80	13.73	1.99	8.02	16.30	12.35	13.73	15.50
19	40	13.28	13.28	2.44	7.20	16.30	12.35	13.28	15.24
20	40	13.65	14.21	1.75	7.83	16.30	12.60	14.21	14.27
21	40	13.80	13.73	1.99	8.02	16.30	12.35	13.73	15.50
22	40	13.28	13.28	2.44	7.20	16.30	12.35	13.28	15.24
23	40	13.65	14.21	1.75	7.83	16.30	12.60	14.21	14.27
24	40	13.80	13.73	1.99	8.02	16.30	12.35	13.73	15.50
All	960	13.51	13.28	1.81	7.20	23.28	12.60	13.28	14.27

It is obvious that as word complexity increased, the students took a longer time on average to learn a word, as shown in **Figure 19**. On average, the students took 5.02s to learn an easy word using the static system, 9.92s to learn a moderate word using the adaptable system, and 13.51s to learn a difficult word using the adaptive system.

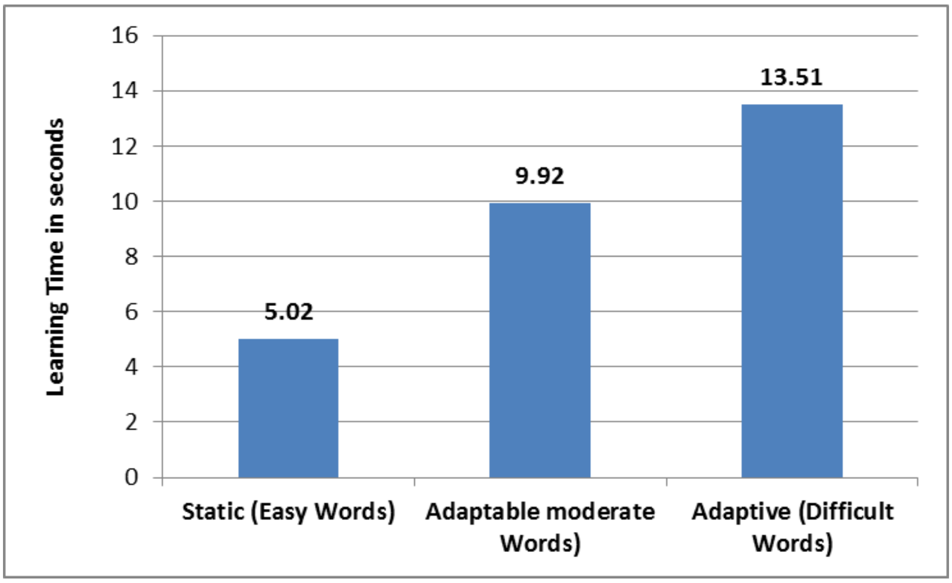

Figure 19: Average learn time

5.18.4 Examination Time for Easy Words Using the Static System

After learning the easy words using the static system, the students then took an examination. Summary statistics for each student are shown on **Table 50**. For example, student 1 took an average of 6.65 seconds to answer an easy word correctly (median = 5.82s). Minimum examination time for an easy word for student 1 was 2.10s and the maximum examination time was 23.02. For student 2, the corresponding figures are average = 12.27, median = 11.22, minimum = 9.17, and maximum = 22.35. The rest of the students' examination times are shown on the table. Overall, the students took 12.77s to answer an easy word (median = 12.12s); the minimum examination time to answer an easy word was 2.10s and the maximum time was 35.07s.

Table 50: Summary statistics of subjects completed examination time using the static systems

Student	Number of Words	Mean	Median	Std. Deviation	Minimum	Maximum	Percentiles 25th (Lower Quarter)	50th (Median)	75th (Upper Quarter)
1	40	6.65	5.82	4.12	2.10	23.02	4.07	5.82	8.33
2	40	12.27	11.22	3.00	9.17	22.35	10.22	11.22	13.09
3	40	12.96	12.96	3.45	2.32	21.18	10.36	12.96	15.03
4	40	12.17	11.91	3.44	4.45	21.65	10.09	11.91	13.56
5	40	13.66	12.30	3.76	10.00	23.20	10.48	12.30	15.64
6	40	13.51	12.48	3.59	8.43	23.20	11.24	12.48	15.22
7	40	13.33	12.35	3.45	8.77	23.15	10.34	12.35	15.14
8	40	13.30	12.15	3.48	9.20	20.32	10.23	12.15	15.44
9	40	11.76	11.28	3.76	2.22	20.28	10.04	11.28	14.20
10	40	13.18	12.27	3.69	8.02	23.20	10.13	12.27	15.79
11	40	14.03	14.20	3.87	7.03	22.23	10.70	14.20	16.75
12	40	14.42	13.12	4.81	8.43	35.07	11.22	13.12	16.04
13	40	13.66	13.23	4.19	5.83	23.20	10.21	13.23	15.98
14	40	13.41	12.21	3.89	9.13	23.15	10.37	12.21	15.04
15	40	12.17	11.31	2.75	9.27	23.02	10.58	11.31	12.51
16	40	14.11	13.27	3.90	8.43	23.20	10.41	13.27	16.18
17	40	13.41	12.21	3.89	9.13	23.15	10.37	12.21	15.04
18	40	12.17	11.31	2.75	9.27	23.02	10.58	11.31	12.51
19	40	14.11	13.27	3.90	8.43	23.20	10.41	13.27	16.18
20	40	13.38	12.21	3.91	9.13	23.15	10.37	12.21	15.04
21	40	12.17	11.31	2.75	9.27	23.02	10.58	11.31	12.51
22	40	12.95	12.30	3.57	7.08	23.15	10.25	12.30	14.74
23	40	12.06	11.21	3.17	4.20	23.15	10.17	11.21	13.17
24	40	11.57	11.23	2.49	6.25	23.02	10.26	11.23	12.15
All	960	12.77	12.12	3.87	2.10	35.07	10.25	12.12	14.64

5.18.5 Examination Time for Moderate Words Using the Adaptable System

After learning the moderate words using the adaptable system, the students then took an examination to assess their learning. Summary statistics for each student are shown in **Table 51**. For example, student 1 took an average of 15.35 seconds to answer a moderate word correctly (median = 15.42s). The minimum examination time for a moderate word for student 1 was 10.15s and the maximum examination time was 23.20s. For student 2, the corresponding figures are average = 13.03, median = 11.33, minimum = 9.17, and maximum = 23.02. The rest of the students' examination times are shown in the table. Overall, the students took 13.61s to answer a moderate word (median = 12.38s); the minimum examination time to answer a moderate word was 8.32s and the maximum time was 35.15s.

Table 51: Summary statistics of subjects completed examination time using the adaptable system

Student	Number of Words	Mean	Median	Std. Deviation	Minimum	Maximum	Percentiles 25th (Lower Quarter)	50th (Median)	75th (Upper Quarter)
1	40	15.35	15.42	3.73	10.15	23.20	12.33	15.42	17.96
2	40	13.03	11.33	3.73	9.17	23.02	10.54	11.33	13.41
3	40	14.00	13.17	4.08	8.43	29.47	11.15	13.17	15.67
4	40	13.69	13.17	2.82	9.60	21.65	11.52	13.17	15.41
5	40	13.89	12.33	3.83	10.00	23.20	10.66	12.33	16.05
6	40	13.52	12.48	3.59	8.43	23.20	11.24	12.48	15.22
7	40	14.04	13.01	4.10	8.77	26.13	10.91	13.01	15.64
8	40	13.43	12.87	3.47	8.43	20.32	10.27	12.87	15.44
9	40	12.98	12.20	3.02	8.32	21.15	10.91	12.20	14.33
10	40	14.63	14.38	3.77	10.15	23.20	11.44	14.38	16.95
11	40	14.65	14.50	3.58	9.17	22.23	11.27	14.50	17.07
12	40	14.44	13.17	4.81	8.43	35.15	11.22	13.17	16.08
13	40	14.12	13.27	3.89	8.43	23.20	10.41	13.27	16.20
14	40	13.43	12.21	3.89	9.13	23.15	10.37	12.21	15.08
15	40	12.19	11.31	2.75	9.27	23.02	10.58	11.31	12.51
16	40	14.12	13.27	3.89	8.43	23.20	10.41	13.27	16.20
17	40	13.43	12.21	3.89	9.13	23.15	10.37	12.21	15.08
18	40	12.19	11.31	2.75	9.27	23.02	10.58	11.31	12.51
19	40	14.12	13.27	3.89	8.43	23.20	10.41	13.27	16.20
20	40	13.43	12.21	3.89	9.13	23.15	10.37	12.21	15.08
21	40	12.19	11.31	2.75	9.27	23.02	10.58	11.31	12.51
22	40	14.12	13.27	3.89	8.43	23.20	10.41	13.27	16.20
23	40	13.43	12.21	3.89	9.13	23.15	10.37	12.21	15.08
24	40	12.19	11.31	2.75	9.27	23.02	10.58	11.31	12.51
All	960	13.61	12.38	3.70	8.32	35.15	11.13	12.38	15.28

5.18.6 Examination Time for Difficult Words Using the Adaptive System

After learning the difficult vocabularies using the adaptive system, the students then took an examination to assess their learning. Summary statistics for each student are shown in **Table 52**. For example, student 1 took an average of 15.37 seconds to answer a difficult word correctly (median = 15.42s). The minimum examination time for a difficult vocabulary for student 1 was 10.12s and the maximum examination time was 23.20s. For student 2, the corresponding figures are average = 13.04, median = 11.33, minimum = 9.17, and maximum = 23.02. The rest of the students' examination times are shown in the table. Overall, the students took 13.62s to answer a moderate word (median = 12.38s); the minimum examination time to answer a moderate word was 7.27s and the maximum time was 35.23s.

Table 52: Summary statistics of subjects completed examination time adaptive system

Student	Number of Words	Mean	Median	Std. Deviation	Minimum	Maximum	Percentiles 25th (Lower Quarter)	Percentiles 50th (Median)	Percentiles 75th (Upper Quarter)
1	40	15.37	15.42	3.72	10.12	23.20	12.33	15.42	18.02
2	40	13.04	11.33	3.73	9.17	23.02	10.54	11.33	13.41
3	40	14.01	13.21	4.07	8.43	29.47	11.22	13.21	15.67
4	40	13.65	13.20	2.91	7.60	21.65	11.52	13.20	15.41
5	40	13.90	12.33	3.82	10.00	23.20	10.66	12.33	16.05
6	40	13.53	12.48	3.59	8.43	23.20	11.24	12.48	15.23
7	40	14.05	13.02	4.10	8.77	26.25	10.93	13.02	15.64
8	40	13.44	12.87	3.47	8.43	20.32	10.27	12.87	15.44
9	40	12.94	12.23	3.09	7.27	21.15	10.92	12.23	14.33
10	40	14.64	14.38	3.76	10.12	23.20	11.44	14.38	16.95
11	40	14.66	14.50	3.59	9.17	22.23	11.28	14.50	17.11
12	40	14.45	13.21	4.82	8.43	35.23	11.27	13.21	16.17
13	40	14.13	13.27	3.89	8.43	23.20	10.41	13.27	16.22
14	40	13.44	12.23	3.89	9.13	23.15	10.37	12.23	15.10
15	40	12.20	11.31	2.74	9.27	23.02	10.58	11.31	12.51
16	40	14.13	13.27	3.89	8.43	23.20	10.41	13.27	16.22
17	40	13.44	12.23	3.89	9.13	23.15	10.37	12.23	15.10
18	40	12.20	11.31	2.74	9.27	23.02	10.58	11.31	12.51
19	40	14.13	13.27	3.89	8.43	23.20	10.41	13.27	16.22
20	40	13.44	12.23	3.89	9.13	23.15	10.37	12.23	15.10
21	40	12.20	11.31	2.74	9.27	23.02	10.58	11.31	12.51
22	40	14.13	13.27	3.89	8.43	23.20	10.41	13.27	16.22
23	40	13.44	12.23	3.89	9.13	23.15	10.37	12.23	15.10
24	40	12.20	11.31	2.74	9.27	23.02	10.58	11.31	12.51
All	960	13.62	12.38	3.70	7.27	35.23	11.15	12.38	15.28

It is obvious that as word complexity increased, the students took a longer time on average to answer a word correctly, as shown in **Figure 20**. On average, the students took 12.77s to answer an easy word using the static system; students took 13.61s to answer a moderate word using the adaptable system and 13.62s to answer a difficult word using the adaptive system. There is not much difference between the adaptable and adaptive examination times.

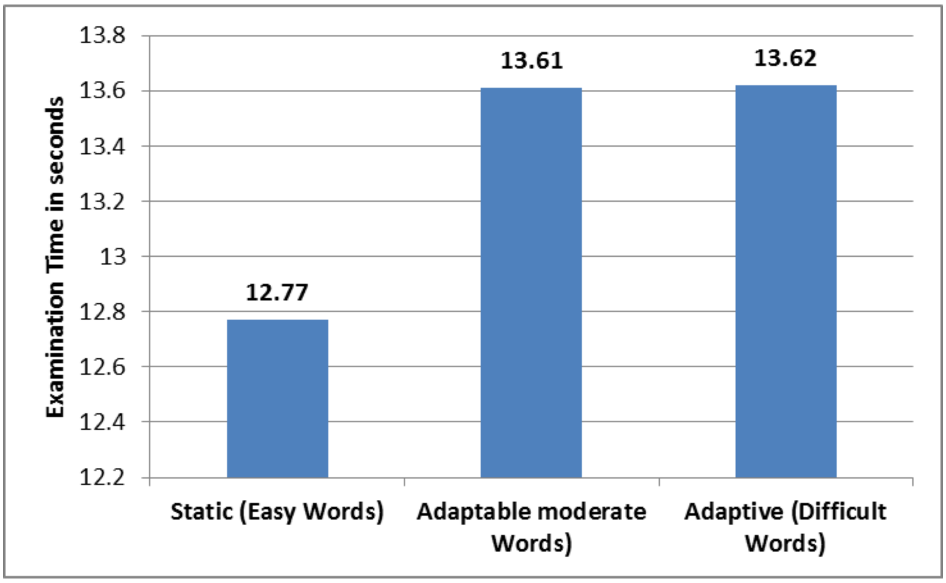

Figure 20: Average examination time

5.18.7 Learning Time Errors

The students that made errors during learning time for the three systems are shown in **Table 53**. For example, student 1 made four errors while student 2 made seven errors. In total the students made 20 errors using the static system during learning time. For the adaptable system, a total of 18 errors were made. Similarly, for the adaptive system, a total of 18 errors were also made.

Note that there were 40 easy words and 24 students, therefore making a total of 960 occasions (40 x 24 = 960). The error rate of the static system was 20 in 960 (2%), for the adaptable system it was 18 in 960 (1.9%), and for the adaptive system it was also 18 in 960 (1.9%).

During learning time, slightly more errors were made using the static system compared to both the adaptable and adaptive systems.

Table 53: Number of errors during learning time for the three systems

System	Student	Number of Errors made during Learning Time	Percentage Error Rate
Static	1	4	2.0%
	2	7	
	3	2	
	5	2	
	6	2	
	10	1	
	11	1	
	23	1	
	Total	20	
Adaptable	1	4	1.90%
	2	7	
	3	2	
	5	2	
	6	2	
	11	1	
	Total	18	
Adaptive	1	4	1.90%
	2	7	
	3	2	
	5	2	
	6	2	
	11	1	
	Total	18	

5.18.8 Examination Time Errors

The students that made errors during examination time for the three systems are shown in **Table 54**. For example, student 1 made one error while student 2 also made 1 error. In total the students made 2 errors using the static system during examination time. For the adaptable system, no errors were made. Similarly, no errors were made for the adaptive system, either.

The error rate of the static system was 2 in 960 (0.2%), for the adaptable system it was 0 in 960 (0%), and for the adaptive system it was also 0 in 960 (0%).

During examination time, slightly more errors were made using the static system compared to both the adaptable and adaptive systems.

Table 54: Number of Error during examination time for the three systems

System	Student	Number of errors made during examination time	Percentage error rate
Static	1	1	0.20%
	22	1	
	Total	2	
Adaptable			0%
Adaptive			0%

5.18.9 Conclusion

Learning Time/Error: On average, students took 5.02s to learn an easy word using the static system, 9.92s to learn a moderate word using the adaptable system, and 13.51s to learn a difficult word using the adaptive system. During learning time, slightly more errors were made using the static system compared to both the adaptable and adaptive systems.

Examination Time/Error: On average, the student took 12.77s to answer an easy word using the static system, 13.61s to answer a moderate word using the adaptable system, and 13.62s to answer a difficult word using the adaptive system. There was not much difference between the adaptable and adaptive system examination times. During examination time, slightly more errors were made using the static system compared to both the adaptable and adaptive systems.

The evaluation obtained from SUS items. Some people may argue that responses on individual items on the researcher questionnaire are not meaningful and, therefore, the previous analysis may be suspect. Because of this, the researcher decided to look at the analysis again using SUS analysis. The SUS yields a single number representing a composite measure of the overall usability of the system. To arrive at a SUS score, the researcher did the following:

- For positive statements: subtract one from the user response.
- For negative statements: subtract the user responses from 5.

This scales all values from 0 to 4 (with four being the most positive response). So the SUS score will range from 0 to 48 because there are 12 statements on the questionnaire. Some researchers will scale this up to a 100, but the researcher has decided that this is not necessary because it will have no effect on the statistical analysis.

The researcher then analysed the SUS score to find out if there were any differences between the systems. The researcher decided to compare all three systems together (i.e., static, adaptable and adaptive). The reason for this was that the SUS score is used as a way to confirm the previous analysis.

5.18.10 Characteristics of Participants

In total, 66 students took part in this research. The characteristics and features of the participants are discussed below. The students were divided into two groups: static and adaptable. SPSS version 21 was used to analyse the data in this research.

5.18.10.1 Gender Distribution

For the total sample, the majority of the participants were male 41 (62.1%) and the number of female participants was 25 (37.9%), as shown in **Table 55**. There were 20 males (60.6%) and 13 females (39.4%) in the static group. The adaptable group was the corresponding figures were 21 male (63.6%) and 12 female (36.4%) participants. The proportions of male and female participants in the two groups were very similar.

Table 55: Gender distribution of participants

Gender	Count /% within Group	Group		Total
		Static	Adaptable	
Female	Count	13	12	25
	% within Group	39.4	36.4	37.9
Male	Count	20	21	41
	% within Group	60.6	63.6	62.1
Total	Count	33	33	66
	% within Group	100.0	100.0	100.0

5.18.10.2 Highest Level of Education

For the sample as a whole, the distribution of the participants by highest level of education is shown on **Table: 56.** The majority of participants (34) were post-graduates (51.5%); this was followed by 16 (24.2%) who were college/university students, and 8 participants who were in high school or had some college/university education (12.1%) each. The proportions were exactly the same for the two groups, as shown in **Table: 56.**

Table 56: Distribution of participants by highest level of Education

Highest Level of Education	Count/% within Group	Group		Total
		Static	Adaptable	
College/University	Count	8	8	16
	% within Group	24.2	24.2	24.2
High School Graduate	Count	4	4	8
	% within Group	12.1	12.1	12.1
Post-Graduate	Count	17	17	34
	% within Group	51.5	51.5	51.5
Some College/University	Count	4	4	8
	% within Group	12.1	12.1	12.1
Total	Count	33	33	66
	% within Group	100.0	100.0	100.0

Mother Language

The mother language for all 66 participants was Arabic.

5.18.10.3 Internet Use

For the entire sample, the distribution of how long the participants had used the Internet is shown on (**Table 57).** The majority, 40 participants (60.6%), had used the Internet for more than 10 years; 16 participants (24.2%) had used the Internet for 4 to 6 years; 8 participants (12.1%) had used the Internet for 1 to 3 years, and only 2 participants (3%) had used the Internet for less than 1 year. As for highest education, the proportions were exactly the same for the two groups, as shown in **Table 57.**

Table 57: Distribution of Internet use by Participants

Time Using Internet	Count/% within Group	Group		Total
		Static	Adaptable	
6 to 12 months	Count	1	1	2
	% within Group	3.0	3.0	3.0
1 to 3 years	Count	4	4	8
	% within Group	12.1	12.1	12.1
4 to 6 years	Count	8	8	16
	% within Group	24.2	24.2	24.2
10 years or more	Count	20	20	40
	% within Group	60.6	60.6	60.6
Total	Count	33	33	66
	% within Group	100.0	100.0	100.0

5.18.10.4 Age Distribution of Participants

Within the sample, 32 participants (48.5%) are 30–40 years old and 34 participants (51.5%) are 18–30 years old, as shown in **Table 58.** The proportions for the two groups are exactly the same as for the whole sample, as shown in **Table 58**.

Table 58: Age Distribution of Participants

Age Group	Count /% within Group	Group		Total
		Static	Adaptable	
18–30	Count	17	17	34
	% within Group	51.5	51.5	51.5
30–40	Count	16	16	32
	% within Group	48.5	48.5	48.5
Total	Count	33	33	66
	% within Group	100.0	100.0	100.0

5.18.10.5 Change Software Setting

Within the entire sample, the majority of participants 42 (63.6%) had changed software settings when necessary. Eight participants (12.1%) had never changed software settings. Six participants (9.1%) had changed software settings every time they used new software, and 10 participants (15.2%) had changed software insertion when they got errors (see **Table 59**). The proportions for the two groups are exactly the same as that of the whole sample, as shown in **Table 59**.

Table 59: Change of software setting

Have you ever changed software settings?	Count/% within Group	Group: Static	Group: Adaptable	Total
No, never	Count	4	4	8
	% within Group	12.1	12.1	12.1
Yes, every time I use	Count	3	3	6
	% within Group	9.1	9.1	9.1
Yes, when I get some	Count	5	5	10
	% within Group	15.2	15.2	15.2
Yes, when I need to	Count	21	21	42
	% within Group	63.6	63.6	63.6
Total	Count	33	33	66
	% within Group	100.0	100.0	100.0

5.19 Evaluation of Static System

After looking at characteristics of the participants, the researchers looked at how they evaluate the static system. The researchers asked the participants to evaluate the static system using 12 statements, as shown in **Table 60.** The participants evaluated each question by selecting one of the following: 5=*Strongly Agree*, 4=*Agree*, 3=*Neutral*, 2=*Disagree* and 1=*Strongly Disagree*. Frequency analysis is used to analyse the data because it provides the count (frequency) and present for each selection made by the participants. The responses given by the participants are shown in **Ta-**

ble 60. For example, for the statement ***I think that I would like to use this website frequently,*** 19 participants (57.6%) selected *strongly agree* and 14 participants (42.4%) selected *strongly disagree*. This suggests that a slightly higher proportion of participants will use the website frequently.

For the statement ***I found this website unnecessarily complex,*** 3 participants (9.1%) selected *agree*, 17 participants (51.5%) selected *strongly agree*, and 13 participants (39.4%) selected *strongly disagree*. Combining *agree* and *strongly agree*, 60.6% of the participants found the website unnecessarily complex and 39.4% thought it was not unnecessarily complex.

For the statement ***I thought this website was easy to use,*** 2 participants (6.1%) selected *agree*, 13 participants (39.4%) selected *strongly agree*, and 18 participants (54.5%) selected *strongly disagree*. Combining *agree* and *strongly agree*, 45.5% of the participants thought the website was easy to use, and the majority (54.5%) thought the website was not easy. This statement agrees with the last statement (***I found this website unnecessarily complex)***.

1 Table 60: Evaluation of static system by participants

Statement	Agree		Strongly Agree		Strongly Disa-gree	
	Count	Row %	Count	Row %	Count	Row %
I think that I would like to use this website frequently.	0	0.0	19	57.6	14	42.4
I found this website unnecessarily complex.	3	9.1	17	51.5	13	39.4
I thought this website was easy to use.	2	6.1	13	39.4	18	54.5
I think that I would need assistance to be able to use this website.	4	12.1	7	21.2	22	66.7
I found the various functions in this website were well integrated.	2	6.1	15	45.5	16	48.5
I thought there was too much inconsistency in this website.	1	3.0	15	45.5	17	51.5
I would imagine that most people would learn to use this website very quickly.	3	9.1	13	39.4	17	51.5
I found this website very slow/awkward to use.	4	12.1	10	30.3	18	54.5
I felt very confident using this website.	1	3.0	11	33.3	21	63.6
I needed to learn a lot of things before I could get going with this website.	3	9.1	17	51.5	13	39.4
I felt the system helped me to study words and their meanings.	0	0.0	19	57.6	14	42.4
I think that I would need assistance to be able to learn words.	1	3.0	8	24.2	24	72.7

For the statement ***I think that I would need assistance to be able to use this website,*** 4 participants (12.1%) selected *agree,* 7 participants (21.2%) selected *strongly agree,* and the majority of participants, 22 (66.7%), selected *strongly disagree*. Combining *agree* and *strongly agree*, 33.3% of the participants thought they would need assistance to be able to use the website and 66.7% of participants thought they will be able to use the website without any assistance.

For the statement ***I found the various functions in this website were well integrated,*** 2 participants (6.1%) selected *agree*, 15 participants (45.5%) selected *strongly agree,* and 16 participants (48.5%) selected *strongly disagree*. Combining *agree* and *strongly agree*, 51.5% of the participants found the various functions in the website well integrated and 48.5% of participants did not find the various functions in the website well integrated.

For the statement ***I thought there was too much inconsistency in this website,*** 1 participant (3%) selected *agree,* 15 participants (45.5%) selected *strongly agree,* and 17 participants (51.5%) selected *strongly disagree*. Combining *agree* and *strongly agree,* 48.5% of the participants thought there was too much inconsistency in the website and 51.5% of participants disagreed that there was too much inconsistency in the website.

For the statement ***I would imagine that most people would learn to use this website very quickly,*** 3 participants (9.1%) selected *agree*, 13 participants (39.4%) selected *strongly agree,* and 17 participants (51.5%) selected *strongly disagree*. Combining *agree* and *strongly agree,* 48.5% of the participants believed that most people would learn to use this website very quickly; however, 51.5% of participants disagreed.

For the statement ***I found this website very slow/awkward to use,*** 4 participants (12.1%) selected *agree*, 10 participants (30.3%) selected *strongly agree,* and 18 participants (54.5%) selected *strongly disagree*. Combining *agree* and *strongly agree,* 42.4% of the participants found the website very slow/awkward to use; however, 18 of participants (54.5%) disagreed.

For the statement ***I felt very confident using this website,*** 1 participant (3%) selected *agree*, 11 participants (33.3%) selected *strongly agree,* and 21 participants (63.6%) selected *strongly disagree*. Combining *agree* and *strongly agree,* 36.3% of the participants felt very confident using the website; however, the majority of participants (63.6%) did not feel confident using the website.

For the statement ***I needed to learn a lot of things before I could get going with this website,*** 3 participants (9.1%) selected *agree*, 17 participants (51.5%) selected *strongly agree,* and 13 participants (39.4%) selected *strongly disagree*. Combining *agree* and *strongly agree,* 60.6% of the participants felt they needed to learn a lot of things before they could get going with the website; however, 39.4% of participants disagreed.

For the statement ***I felt the system helped me to study words and their meanings,*** 19 participants (57.6%) selected *strongly agree* and 14 participants (42.4%) selected *strongly disagree*. The majority of the participants strongly agreed that the system helped them to study new words and meaning.

For the statement ***I think that I would need assistance to be able to learn words,*** 1 participant (3%) selected *agree*, 8 participants (24.2%) selected *strongly agree,* and 24 participants (72.7%) selected *strongly disagree*. Combining *agree* and *strongly agree,* 27.2% of the participants thought that they would need assistance to be able to learn words, but majority (72.7%) of participants thought that they would not need assistance to be able to learn words.

5.19.1 Summary of Participants Evaluation of Static System

There seem to be mixed feelings from participants towards the website. The majority of participants would use the website frequently even though they think it is unnecessarily complex. However, the majority indicated that it was not easy to use and that they would need assistance to use the website. The website was not slow/awkward, but participants were not confident using it. Participants also felt that they needed to learn lots of things before they used the website. They agreed that the website helped them to learn new words and their meanings, and that they did not need assistance to learn new words.

5.20 Evaluation of Adaptable System

We now look at how the participants evaluated the adaptable system. As for the static system, the researchers asked the participants to evaluate the adaptable system using the 12 statements and the same scale. The responses given by the participants are shown in **Table 61**. As an example, for the statement ***I think that I would like to use this website frequently,*** 20 participants (60.6%) selected *strongly agree* and 13 participants (39.4%) selected *strongly disagree*. This suggests that a higher proportion of participants will use the website frequently.

For the statement ***I found this website unnecessarily complex,*** 3 participants (9.1%) selected *agree*, 18 participants (54.5%) selected *strongly agree,* and 12 participants (36.4%) selected *strongly disagree*. Combining *agree* and *strongly agree*, 63.6% of the participants found the website unnecessarily complex and 36.4% thought it was not unnecessarily complex.

For the statement ***I thought this website was easy to use,*** 4 participants (12.1%) selected *agree*, 12 participants (36.4%) selected *strongly agree,* and 17 participants (51.5%) selected *strongly disagree*. Combining *agree* and *strongly agree*, 48.5% of the participants thought the website was easy to use, but the majority (54.5%) thought the website was not easy.

For the statement ***I think that I would need assistance to be able to use this website,*** 4 participants (12.1%) selected *agree*, 6 participants (18.2%) selected *strongly agree,* 1 (3%) participant selected *disagree,* and the majority of participants, 22 (66.7%), selected *strongly disagree*. Combining *agree* and *strongly agree,* 30.4% of the participants thought they would need assistance to be able to use the website and 69.7% of participants thought they would be able to use the website without any assistance.

For the statement ***I found the various functions in this website were well integrated,*** 2 participants (6.1%) selected *agree*, 15 participants (45.5%) selected *strongly agree,* and 16 participants (48.5%) selected *strongly disagree*. Combining *agree* and *strongly agree*, 51.5% of the participants found the various functions in the website well integrated and 48.5% of participants did not find the various functions in the website well integrated.

For the statement ***I thought there was too much inconsistency in this website,*** 3 participants (9.1%) selected *agree*, 13 participants (39.4%) selected *strongly agree,* 1 (3%) participant selected *disagree,* and 16 participants (48.5%) selected *strongly disagree*. Combining *agree* and *strongly agree,* 48.5% of the participants thought there was too much inconsistency in the website and 51.5% of participants disagreed that there was too much inconsistency in the website.

Table 61: Evaluation of adaptable system by participants

Statement	Strongly Disagree		Disagree		Agree		Strongly Agree	
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
I think that I would like to use this website frequently.	13	39.4	0	0.0	0	0.0	20	60.6
I found this website unnecessarily complex.	12	36.4	0	0.0	3	9.1	18	54.5
I thought this website was easy to use.	17	51.5	0	0.0	4	12.1	12	36.4
I think that I would need assistance to be able to use this website.	22	66.7	1	3.0	4	12.1	6	18.2
I found the various functions in this website were well integrated.	16	48.5	0	0.0	2	6.1	15	45.5
I thought there was too much inconsistency on this website.	16	48.5	1	3.0	3	9.1	13	39.4
I would imagine that most people would learn to use this website very quickly.	17	51.5	0	0.0	3	9.1	13	39.4
I found this website very slow/awkward to use.	17	53.1	0	0.0	4	12.5	11	34.4
I felt very confident using this website.	18	54.5	1	3.0	3	9.1	11	33.3
I needed to learn a lot of things before I could get going with this website.	12	36.4	0	0.0	5	15.2	16	48.5
I felt the system helped me to study words and their meanings.	12	36.4	1	3.0	2	6.1	18	54.5
I think that I would need assistance to be able to learn words.	23	69.7	0	0.0	2	6.1	8	24.2

For the statement ***I would imagine that most people would learn to use this website very quickly,*** 3 participants (9.1%) selected *agree*, 13 participants (39.4%) selected *strongly agree,* and 17 participants (51.5%) selected *strongly disagree*. Combining *agree* and *strongly agree,* 48.5% of the participants imagined that most people would learn to use this website very quickly; however, 51.5% of the participants disagreed.

For the statement ***I found this website very slow/awkward to use,*** 4 participants (12.5%) selected *agree*, 11 participants (34.4%) selected *strongly agree,* and 17 participants (53.1%) selected *strongly disagree*. Combining *agree* and *strongly agree,* 46.9% of the participants found the website very slow/awkward to use; however, 18 participants (53.1%) disagreed.

For the statement ***I felt very confident using this website,*** 3 participants (9.1%) selected *agree*, 11 participants (33.3%) selected *strongly agree,* 1 participant (3%) selected *disagree,* and 18 participants (54.5%) selected *strongly disagree*. Combining *agree* and *strongly agree,* 42.4% of the participants felt very confident using the website; however, the majority of participants (57.5%) did not feel confident using the website.

For the statement ***I needed to learn a lot of things before I could get going with this website,*** 5 participants (15.2%) selected *agree*, 16 participants (48.5%) selected *strongly agree,* and 12 participants (36.4%) selected *strongly disagree*. Combining *agree* and *strongly agree*, 63.7% of the participants felt they needed to learn a lot of things before they could get going with the website; however, 36.4% of participants disagreed.

For the statement ***I felt the system help me to study words and their meanings,*** 2 participants (6.1%) selected *agree*, 18 participants (54.5%) selected *strongly agree*, 1 participant (3%) selected *disagree,* and 12 participants (36.4%) selected *strongly dis-*

agree. The majority of the participants (60.6%) strongly agreed that the system helped them to study new words and meanings, while 39.4% disagreed.

For the statement ***I think that I would need assistance to be able to learn words,*** 2 participant (6.1%) selected *agree*, 8 participants (24.2%) selected *strongly agree*, and 23 participants (69.7%) selected *strongly disagree*. Combining *agree* and *strongly agree*, 30.3% of the participants think that they would need assistance to be able to learn words, but the majority (69.7%) of participants think that they would not need assistance to be able to learn words.

5.20.1 Summary of Participants' Evaluation of the Adaptable System

The majority of participants will use the website frequently even though they think it is unnecessarily complex. Even though they indicated that it was not easy to use, the majority said they would not need assistance to use the website. The website was not slow/awkward, but participants were not confident using it. Participants also felt that they need to learn lots of things before they use the website. They agreed that the website helped them to learn new words and their meanings and those they do not need assistance to learn new words. This summary is not that different from the summary for the static system.

5.21 Comparison between Static and Adaptable Systems

The researcher has taken each statement and made a comparison between the two systems. For this comparison *agree/strongly agree* has been grouped together and is simply referred to as *agree*. Similarly, *disagree/strongly disagree* are grouped together and are referred to as *disagree*. The statistical method used for this part of the analysis is the chi-square test. This method was used because the researchers wanted to see if there is any association between two categorical variables (Norusis 1998, p310). In this test, the two variables are the answers to each statement (agree/disagree) and the group (static/adaptable).

I think that I would like to use this website frequently. For this statement, we have already seen that 57.6% of the static group participants agree and 42.4% disagree. For the adaptable group, the corresponding proportions are 60.6% and 39.4%, respectively. A higher proportion from the adaptable group agreed and a smaller proportion disagreed compared to the static group. This indicates that the participants prefer to use the adaptable system; however, there is no significant difference in the proportions with a chi-square value of 0.063, df of 1, and p = 0.80 (>0.05) (see **Table 62)**.

Table 62: Comparison between static and adaptable systems for the statement "*I think that I would like to use this site frequently"*

Question	Answers	Count / % within Group	Group		Total
			Static	Adaptable	
I think that I would like to use this website frequently.	Disagree	Count	14	13	27
		% within Group	42.4%	39.4%	40.9%
	Agree	Count	19	20	39
		% within Group	57.6%	60.6%	59.1%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.063, df = 1, p = 0.80 (>0.05)					

I found this website unnecessarily complex. For this statement, we have already seen that 60.6% of the static group participants agree while 39.4% disagree. For the adaptable group, the corresponding proportions are 63.6% and 36.4%, respectively. A higher proportion from the adaptable group agreed while a smaller proportion disagreed compared to the static group. This indicates that a slightly higher proportion of the participants agree that the adaptable system is complex compared to the proportion of participants to who think that the static system is complex. However, there is no significant difference in the proportions with a chi-square value of 0.064, df of 1, and $p = 0.80$ (>0.05) (see **Table 63)**.

Table 63: Comparison between static and adaptable systems on statement: "*I found this website un-necessary complex*"

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptable	
I found this website un-necessarily complex.	Disagree	Count	13	12	25
		% within Group	39.4%	36.4%	37.9%
	Agree	Count	20	21	41
		% within Group	60.6%	63.6%	62.1%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.064, df = 1, $p = 0.80$ (>0.05)					

I thought this website was easy to use. We have already seen that 45.5% of the static group participants agreed with this statement and that 54.5% disagreed. For the adaptable group, the corresponding proportions are 51.6% and 48.5%, respectively. For both systems, more than 50% of participants disagreed with the statement. This indicates that the websites of the static and adaptable systems are not easy to use. However, there is no significant difference in the proportions with a chi-square value of 0.061, a df of 1, and a $p = 0.81$ (>0.05) (see **Table 64)**.

Table 64: Comparison between static and adaptable systems on the statement: "*I thought this website was easy to use"*

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptable	
I thought this website was easy to use.	Disagree	Count	18	17	35
		% within Group	54.5%	51.5%	53.0%
	Agree	Count	15	16	31
		% within Group	45.5%	48.5%	47.0%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.061, df = 1, $p = 0.81$ (>0.05)					

I think that I would need assistance to be able to use this website. With respect to this statement, only 33.3% of the static group participants agreed while 66.7% disagreed. For the adaptable group, the corresponding proportions are 30.3% and 69.7%, respectively. A higher proportion from the adaptable group disagreed while a smaller proportion agreed compared to the static group. This indicates that a slightly higher proportion of the participants disagreed that they need assistance to use adaptable system, compared to the proportion of participants who disagreed that they need assistance to use the static system. However, there is no significant difference in the proportions with a chi-square value of 0.070, df of 1, and p = 0.79 (>0.05), (see **Table 65**).

Table 65: Comparison between static and adaptable systems on the statement *"I think I would need assistance to be able to use this website"*

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptable	
I think that I would need assistance to be able to use this website.	Disagree	Count	22	23	45
		% within Group	66.7%	69.7%	68.2%
	Agree	Count	11	10	21
		% within Group	33.3%	30.3%	31.8%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.070, df = 1, p = 0.79 (>0.05)					

I found the various functions in this website were well integrated. We have already seen that 51.5% of the static group participants agreed while 48.5% disagreed with this statement. For the adaptable group, the corresponding proportions are exactly the same (see **Table 66**). There is no significant difference in the proportions with a chi-square value of 0.001, df of 1, and p = 0.1.00 (>0.05), (see **Table 66**).

Table 66: Comparison between static and adaptable systems on statement, *"I found the functions in this website were well integrated"*

Question	Answers	Count / % within Group	Group		Total
			Static	Adaptable	
I found the various functions in this website were well integrated.	Disagree	Count	16	16	32
		% within Group	48.5%	48.5%	48.5%
	Agree	Count	17	17	34
		% within Group	51.5%	51.5%	51.5%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.001, df = 1, *p* = 1.00 (>0.05)					

I thought there was too much inconsistency in this website. We have already seen that 48.5% of the static group participants agree while 51.5% disagree. For the adaptable group, the corresponding proportions are exactly the same (see **Table 67**) as for the last statement. There is no significant difference in the proportions with a chi-square value of 0.001, df of 1, and p = 0.1.00 (>0.05) (see **Table 67**).

Table 67: Comparison between static and adaptable systems on statement: *"I thought there was too much inconsistency in this website"*

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptable	
I thought there was too much inconsistency in this website.	Disagree	Count	17	17	34
		% within Group	51.5%	51.5%	51.5%
	Agree	Count	16	16	32
		% within Group	48.5%	48.5%	48.5%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.001, df = 1, *p* = 1.00 (>0.05)					

I would imagine that most people would learn to use this website very quickly. We have already seen that 48.5% of the static group participants agree while 51.5% disagree. For the adaptable group, the corresponding proportions are exactly the same (see **Table 68**) as for the last statement. There is no significant difference in the proportions with a chi-square value of 0.001, df of 1, and p = 0.100 (>0.05) (see **Table 68**).

Table 68: Comparison between the static system and adaptable systems for the statement: *“I would imagine that most people would learn to use this website very quickly"*

Question	Answers	Count / % within Group	Group		Total
			Static	Adaptable	
I would imagine that most people would learn to use this website very quickly.	Disagree	Count	17	17	34
		% within Group	51.5%	51.5%	51.5%
	Agree	Count	16	16	32
		% within Group	48.5%	48.5%	48.5%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.001, df = 1, p = 1.00 (>0.05)					

I found this website very slow/awkward to use. We have already seen that 43.8% of the static group participants agree while 56.3% disagree. For the adaptable group, the corresponding proportions are 46.9% and 53.1%, respectively. A higher proportion from the static group disagreed while a smaller proportion agreed, compared to the adaptable group. This indicates that a slightly higher proportion of the participants disagree that the website for the static system is slow/awkward compare to the proportion of participants to who disagree that the website of the adaptable system is slow/awkward; however, there is no significant difference in the proportions with a chi-square value of 0.063, df of 1, and p = 0.80 (>0.05) (see **Table 69**).

Table 69: Comparison between the static and adaptable systems for the statement *"I found this website very slow/awkward to use"*

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptable	
I found this website very slow/awkward	Disagree	Count	18	17	35
		% within Group	56.3%	53.1%	54.7%

to use.	Agree	Count	14	15	29
		% within Group	43.8%	46.9%	45.3%
Total		Count	32	32	64
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.063, df = 1, *p* = 0.80 (>0.05)					

I felt very confident using this website. We have already seen that only 36.4% of the static group participants agreed with this statement while 63.6% disagreed. For the adaptable group, the corresponding proportions are 42.4% and 57.6%, respectively. Compared to the adaptable group, a higher proportion from the static group disagreed while a smaller proportion agreed. This indicates that a slightly higher proportion of the participants disagree that they felt confident using the static system website compare to the proportion of participants who felt confident using the adaptable system website; however, there is no significant difference in the proportions with a chi-square value of 0.254, df of 1, and *p* = 0.61 (>0.05) (see **Table 70)**.

Table 70: Comparison between the static and adaptable systems for the statement *"I felt very confident using this website"*

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptable	
I felt very confident using this website.	Disagree	Count	21	19	40
		% within Group	63.6%	57.6%	60.6%
	Agree	Count	12	14	26
		% within Group	36.4%	42.4%	39.4%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.254, df = 1, *p* = 0.61 (>0.05)					

I needed to learn a lot of things before I could get going with this website. We have already seen that 60.6% of the static group participants agreed with this statement while 39.4% disagreed. For the adaptable group, the corresponding proportions were 63.6% and 36.4%, respectively. A higher proportion from the adaptable group agreed while a smaller proportion disagreed compared to the static group. This indicates that a slightly higher proportion of the participants agreed that they needed to learn a lot before they could get going with the adaptable system website compared to the proportion of participants who needed to learn a lot before they could get going with the static system website. However, there was no significant difference in the proportions with a chi-square value of 0.064, df of 1, and $p = 0.80$ (>0.05) (see **Table: 71**).

Table 71: Comparison between the static and adaptable systems for the statement "*I need to learn a lot of things before I could get going with this website*"

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptable	
I needed to learn a lot of things before I could get going with this website	Disagree	Count	13	12	25
		% within Group	39.4%	36.4%	37.9%
	Agree	Count	20	21	41
		% within Group	60.6%	63.6%	62.1%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.064, df = 1, p = 0.80 (>0.05)					

I felt the system helped me to study words and their meanings. We have already seen that 57.6% of the static group participants agreed with this statement while 42.4% disagreed. For the adaptable group, the corresponding proportions are 60.6% and 39.4%, respectively. Compared to the static group, a higher proportion from the adaptable group agreed while a smaller proportion disagreed. This indicates that a slightly higher proportion of the participants agreed that the adaptable system website helped them to learn words and their meanings compare to the proportion of participants in static group. However, there is no significant difference in the proportions with a chi-square value of 0.063, df of 1, and $p = 0.80$ (>0.05)0 (see **Table 72**).

Table 72: Comparison between the static and adaptable systems for the statement *"I felt the system helped me to study words and their meanings"*

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptable	
I felt the system helped me to study words and their meanings.	Disagree	Count	14	13	27
		% within Group	42.4%	39.4%	40.9%
	Agree	Count	19	20	39
		% within Group	57.6%	60.6%	59.1%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.063, df = 1, p = 0.80 (>0.05)					

I think that I would need assistance to be able to learn words. We have already seen that only 27.3% of the static group participants agree with this statement while 72.7% disagree. For the adaptable group, the corresponding proportions are 30.3% and 69.7% respectively. A higher proportion from the static group disagreed while a smaller proportion agreed, compared to the adaptable group. This indicates that a slightly higher proportion of the participants disagree that they need assistance with the static system to be able to learn words compared to the adaptable system website. However, there is no significant difference in the proportions with a chi-square value of 0.074, df of 1, and p = 0.79 (>0.05) (see **Table 73**).

Table 73: Comparison between the static and adaptable systems for the statement *"I would need assistance to be able to learn words"*

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptable	
I think that I would need assistance to be able to learn words.	Disagree	Count	24	23	47
		% within Group	72.7%	69.7%	71.2%
	Agree	Count	9	10	19
		% within Group	27.3%	30.3%	28.8%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.074, df = 1, p = 0.79 (>0.05)					

5.22 Summary of Comparison between Static and Adaptable System for each Statement

As the researchers have discussed above, there is no statistically significant difference in any of the 12 statements between the static and adaptable systems as evaluated by the participants. In the minds of the participants, the two systems are perceived to be the same.

5.23 Overall Picture

To gain an overall understanding between the evaluations of the two systems, the researcher calculated the average for each participant for the 12 statements. Before doing this, all the negative statements were reversed to be consistent with the positive statements. Descriptive statistics of the averages are shown in **Table 74**.

Table 74: Descriptive statistics for all 12 statements

Statement	Group					
	Static			Adaptable		
	Mean	Std. Deviation	Median	Mean	Std. Deviation	Median
I think that I would like to use this website frequently.	3.30	2.01	5.00	3.42	1.98	5.00
I found this website unnecessarily complex.	2.67	1.93	1.00	2.55	1.91	1.00
I thought this website was easy to use.	2.76	1.97	1.00	2.82	1.93	1.00
I think that I would need assistance to be able to use this website.	3.79	1.76	5.00	3.88	1.69	5.00
I found the various functions in this website were well integrated.	3.00	1.98	4.00	3.00	1.98	4.00
I thought there was too much inconsistency in this website.	3.09	2.01	5.00	3.12	1.93	4.00
I would imagine that most people would learn to use this website very quickly.	2.85	1.95	1.00	2.85	1.95	1.00
I found this website very slow/awkward to use.	3.38	1.90	5.00	3.25	1.92	5.00
I felt very confident using this website.	2.42	1.92	1.00	2.64	1.90	1.00
I needed to learn a lot of things before I could get going with this website	2.67	1.93	1.00	2.61	1.87	2.00
I felt the system helped me to study words and their meanings.	3.30	2.01	5.00	3.39	1.92	5.00
I think that I would need assistance to be able to learn words.	3.94	1.77	5.00	3.85	1.79	5.00
Over usability (all statements)	3.09	0.68	3.00	3.11	0.66	3.00

The means (averages) and medians for each statement, and the overall, reveal that there are not many differences between the two systems. **Figure 21** shows the overall usability between the two systems.

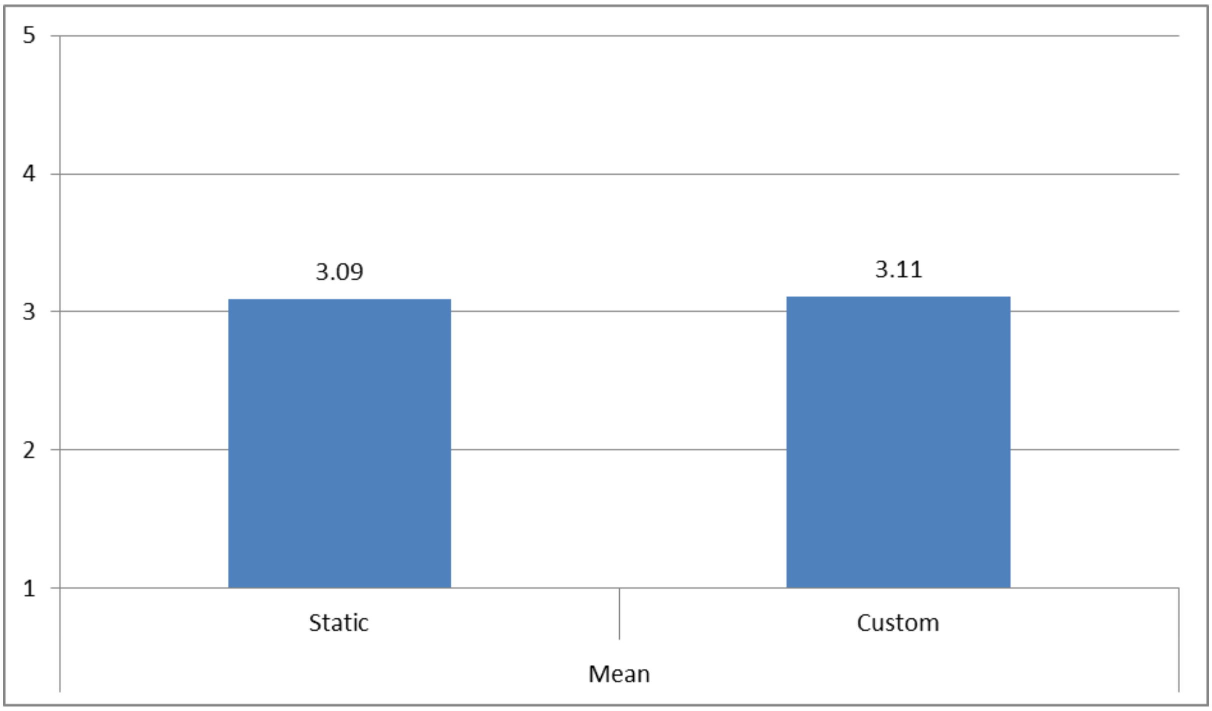

Figure 21: Usability statements between Static and Aaptable (Custom) system

5.24 Average Time for each Task

Descriptive statistics for the average time for each task between the static and adaptable systems are shown in **Table 75**. There is no difference in the average time for each task between the static and adaptable systems.

Table 75: Descriptive Statistics for Average Time (in seconds) for each task

Group	Mean	Std. Deviation	Median
Static	180.73	30.64	175.00
Adaptable	181.18	38.21	170.00
Total	180.95	34.36	175.00

5.25 Total Average Score (Learnability)

To compare how easy it is to learn from each system, the researcher obtained an average total score for each participant. The scores are used to assess the learnability from each system. Summary statistics of the average total score by group is shown in **Table 76**. On average, the participants in the static system achieved lower scores compared to the participants in the adaptable system. Also the static group median value is lower than that of the adaptable group, as shown in **Figure 22**. This may indicate that the participants in the adaptable system learned more than those in the static system.

Table 76: Summary statistics total average score

Group	Mean	Std. Deviation	Minimum	Maximum
Static	45.52	15.04	20.00	70.00
Adaptable	56.45	25.47	20.00	97.00

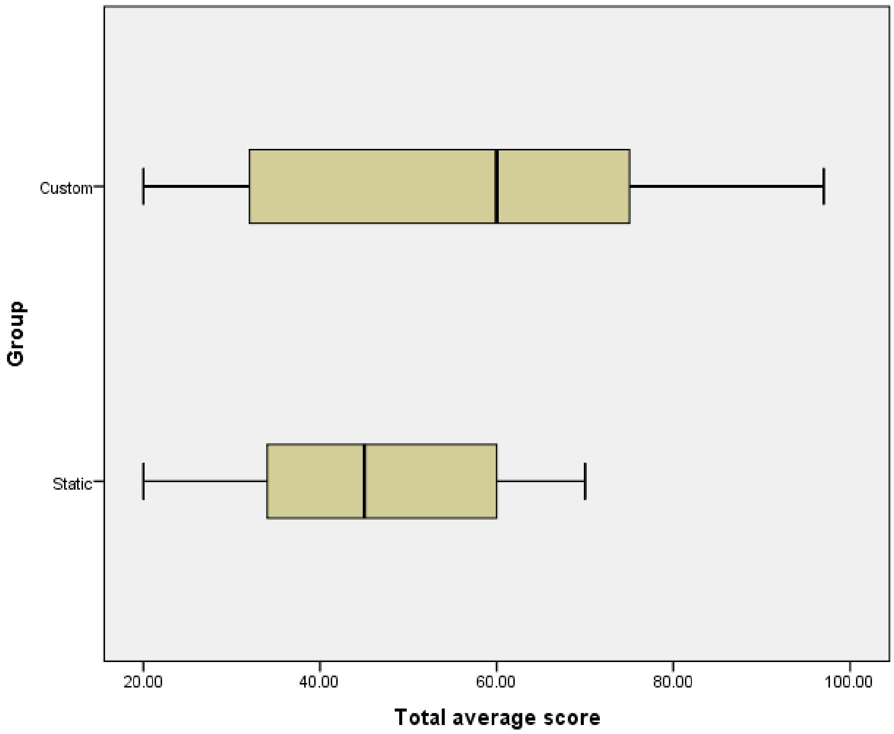

Figure 22: Median score of learnability between static and adaptable groups

To learn if there is a statistically significant difference in the total average scores between the groups, the Mann-Whitney U test was used because the total score was not normally distributed. This test uses median or mean rank, which is more suitable for data that is not normally distributed. The results of the test are shown in **Table77**. The mean rank for the static group was 29.59 and that for the adaptable group was higher at 37.41. However, there was no statistically significant difference between the mean ranks with a Mann-Whitney U value of 415.00 and a *p*-value of 0.097 (>0.05).

Table 77: Comparsion between the static and adaptable groups on total average score

Group	**N**	**Mean Rank**	**Mann-Whitney U**	***p*-value**
Static	33	29.59	415.00	0.097
Adaptable	33	37.41		

5.26 Conclusion

There is no difference in the usability or learnability between the static and adaptable systems at the overall level of the individual statements.

5.27 Evaluation of Adaptive System

We now look at how the participants evaluate the adaptive system. As for both the static and adaptable systems, the researchers asked the participants to evaluate the adaptive system using the same 12 statements and the same scale. The responses given by the participants are shown in **Table 78**. For example, for the statement ***I think that I would like to use this website frequently,*** 13 participants (39.4%) selected *strongly agree* and 7 (21.2%) selected *agree*. On the other side, 9 participants (27.3%) selected *strongly disagree* and 4 (12.1%) selected *disagree*. Therefore, 60.6% *strongly agree*/*agree* while 39.4% *strongly disagree*/*disagree*. This suggests that a higher proportion of participants will use the website frequently.

For the statement ***I found this website unnecessarily complex***, 11 participants (34.4%) selected *strongly agree* and 9 (28.1%) selected *agree*. Conversely, 7 participants (21.9%) selected *strongly disagree* and 5 (15.6%) selected *disagree*. Therefore, 62.5% *strongly agree* or *agree* while 37.4% *strongly disagree* or *disagree*. This suggests that a higher proportion of participants found the website unnecessarily complex.

For the statement ***I thought this website was easy to use***, 8 participants (24.2%) selected *strongly agree* and 8 (24.2%) selected *agree*. Conversely, 11 participants (33.3%) selected *strongly disagree* and 6 (18.2%) selected *disagree*. Therefore, 48.4% *strongly agree* or *agree* while 51.5% *strongly disagree* or *disagree*. This suggests that a higher proportion of participants found the website not easy to use.

For the statement ***I think that I would need assistance to be able to use this website***, 6 participants (18.2%) selected *strongly agree* and 4 (12.1%) selected *agree*. Conversely, 16 participants (48.5%) selected *strongly disagree* and 7 (21.2%) selected *disagree*. Therefore 30.3% *strongly agree* or *agree* while 69.7% *strongly disagree* or *disagree*. This suggests that a higher proportion of participants will not need assistance to be able to use the website.

For the statement ***I found the various functions in this website were well integrated***, 12 participants (36.4%) selected *strongly agree* and 5 (15.2%) selected *agree*. Conversely, 11 participants (33.3%) selected *strongly disagree* and 5 (15.2%) selected *disagree*. Therefore, 51.6% *strongly agree* or *agree* while 48.5% *strongly disagree* or *disagree*. This suggests that a higher proportion of participants found the various functions of the website to be well integrated.

For the statement ***I thought there was too much inconsistency in this website***, 10 participants (30.3%) selected *strongly agree* and 6 (18.2%) selected *agree*. Conversely, 10 participants (30.3%) selected *strongly disagree* and 7 (21.2%) selected *disagree*. Therefore, 48.5% *strongly agree* or *agree* while 51.5% *strongly disagree* or *disagree*. This suggests that a higher proportion of participants did not find too much inconsistency in the website.

Table 78: Evaluation of adaptive system by participants

Statement	Strongly Disagree		Disagree		Agree		Strongly Agree	
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
I think that I would like to use this website frequently.	9	27.3	4	12.1	7	21.2	13	39.4
I found this website unnecessarily complex.	7	21.9	5	15.6	9	28.1	11	34.4
I thought this website was easy to use.	11	33.3	6	18.2	8	24.2	8	24.2
I think that I would need assistance to be able to use this website.	16	48.5	7	21.2	4	12.1	6	18.2
I found the various functions in this website were well integrated.	11	33.3	5	15.2	5	15.2	12	36.4
I thought there was too much inconsistency in this website.	10	30.3	7	21.2	6	18.2	10	30.3
I would imagine that most people would learn to use this website very quickly.	14	42.4	2	6.1	5	15.2	12	36.4
I found this website very slow/awkward to use.	10	31.3	7	21.9	7	21.9	8	25.0
I felt very confident using this website.	13	39.4	5	15.2	6	18.2	9	27.3
I needed to learn a lot of things before I could get going with this website	8	24.2	4	12.1	11	33.3	10	30.3
I felt the system helped me to study words and their meanings.	7	21.2	7	21.2	6	18.2	13	39.4
I think that I would need assistance to be able to learn words.	20	60.6	3	9.1	5	15.2	5	15.2

For the statement ***I would imagine that most people would learn to use this website very quickly,*** 12 participants (36.4%) selected *strongly agree* and 5 (15.2%) selected *agree*. However, 14 participants (42.4%) selected *strongly disagree* and 2 (6.1%) selected *disagree*. Therefore 51.6% *strongly agree* or *agree* while 48.5% *strongly disagree* or *disagree*. This suggests that a higher proportion of participants did imagine that most people would learn to use the website very quickly.

For the statement ***I found this website very slow/awkward to use,*** 8 participants (25%) selected *strongly agree* and 7 (21.9%) selected *agree*. However, 10 participants (31.3%) selected *strongly disagree* and 7 (21.9%) selected *disagree*. Therefore, 46.9% *strongly agree* or *agree* while 53.2% *strongly disagree* or *disagree*. This suggests that a higher proportion of participants did not find the website very slow/awkward to use.

For the statement ***I felt very confident using this website,*** 9 participants (27.3%) selected *strongly agree* and 6 (18.2%) selected *agree*. However, 13 participants (39.4%) selected *strongly disagree* and 5 (15.2%) selected *disagree*. Therefore, 45.5% *strongly agree* or *agree* while 54.6% *strongly disagree* or *disagree*. This suggests that a higher proportion of participants did not feel confident using the website.

For the statement ***I needed to learn a lot of things before I could get going with this website,*** 10 participants (30.3%) selected *strongly agree* and 11 (33.3%) selected *agree*. However, 8 participants (24.2%) selected *strongly disagree* and 4 (12.1%) selected *disagree*. Therefore 63.6% *strongly agree* or *agree* while 36.3% *strongly disagree* or *disagree*. This suggests that a higher proportion of participants did not need to learn a lot of things before they could get going with the website.

For the statement ***I felt the system helped me to study words and their meanings,*** 13 participants (39.4%) selected *strongly agree* and 6 (18.2%) selected *agree*. However, 7 participants (21.2%) selected *strongly disagree* and 7 (21.2%) selected *disagree*.

Therefore 57.6% *strongly agree* or *agree* while 42.4% *strongly disagree* or *disagree*. This suggests that a higher proportion of participants felt the system helped them to study words and their meaning.

For the statement ***I think that I would need assistance to be able to learn words,*** 5 participants (15.2%) selected *strongly agree* and 5 (15.2%) selected *agree*. However, 20 participants (60.9%) selected *strongly disagree* and 3 (9.1%) selected *disagree*. Therefore 30.4% *strongly agree* or *agree* while 69.7% *strongly disagree* or *disagree*. This suggests that a higher proportion of participants did not need assistance to be able to learn words.

5.28 Comparison between Static and Adaptive Systems

In this section, the researcher compares the static system to the adaptive system. The same method used for the comparison between the static and adaptable systems is used.

I think that I would like to use this website frequently. We have already seen that 57.6% of the static group participants agree with this statement while 42.4% disagree. For the adaptive system, the corresponding proportions are 60.6% and 39.4%, respectively. A higher proportion from the adaptive group agreed while a smaller proportion disagreed compared to the static group. This indicates that the participants prefer to use the adaptive system. However, there is no significant difference in the proportions with a chi-square value of 0.063, df of 1, and $p = 0.80$ (>0.05), (see **Table 79**).

Table 79: Comparison between the static and adaptive systems for the statement *"I think that I would like to use this website frequently"*

Question	Answers	Count /% within Group	Group		Total
			Static	Adaptive	
I think that I would like to use this website fre-	Disagree	Count	14	13	27
		% within Group	42.4%	39.4%	40.9%
	Agree	Count	19	20	39

quently		% within Group	57.6%	60.6%	59.1%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.063, df = 1, *p* = 0.80 (>0.05)					

I found this website unnecessarily complex. We have already seen that 60.6% of the static group participants agree with this statement while 39.4% disagree. For the adaptive group, the corresponding proportions are 78.1% and 21.9%, respectively. A higher proportion of participants from the adaptive group agreed while a smaller proportion disagreed compared to the static group. This indicates that a higher proportion of the participants agree that the adaptive system is complex compared to the proportion of participants to who think that the static system is complex. However, there is no significant difference in the proportions with a chi-square value of 2.34, df of 1, and *p* = 0.13 (>0.05) (see **Table: 80**).

Table 80: Comparison between the static and adaptable systems for the statement *"I found the website unnecessarily complex"*

Question	Answers	Count/% within Group	Group: Static	Group: Adaptive	Total
I found this website unnecessarily complex	Disagree	Count	13	7	20
		% within Group	39.4%	21.9%	30.8%
	Agree	Count	20	25	45
		% within Group	60.6%	78.1%	69.2%
Total		Count	33	32	65
		% within Group	100.0%	100.0%	100.0%
Chi-square = 2.34, df = 1, *p* = 0.13 (>0.05)					

I thought this website was easy to use

We have already seen that 45.5% of the static group participants agree with this statement while 54.5% disagree. For the adaptive group, the corresponding proportions are 48.5% and 51.6%, respectively. For both systems, more than 50% of the participants disagreed with the statement. This indicates that the websites of the static and adaptive systems are not easy to use. However, there is no significant difference in the proportions with a chi-square value of 0.061, df of 1, and $p = 0.81$ (>0.05) (see **Table 81).**

Table 81: Comparison between the static and adaptable systems for the statement *"I thought the website was easy to use"*

Question	Answers	Count/% within Group	Group: Static	Group: Adaptive	Total
I thought this website was easy to use.	Disagree	Count	18	17	35
		% within Group	54.5%	51.5%	53.0%
	Agree	Count	15	16	31
		% within Group	45.5%	48.5%	47.0%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.061, df = 1, p = 0.81 (>0.05)					

I think that I would need assistance to be able to use this website. We have already seen that only 33.3% of the static group participants agree with this statement while 66.7% disagree. For the adaptive group, the corresponding proportions are 30.3% and 69.7%, respectively. Compared to the static group, a higher proportion from the adaptive group disagreed while a smaller proportion agreed. This indicates that a slightly higher proportion of the participants disagree that they need assistance to use the adaptive system compared to the proportion of participants who disagree that they need assistance to use the static system. However, there are no significant difference in the proportions with a chi-square value of 0.070, df of 1, and $p = 0.79$ (>0.05) (see **Table 82**).

Table 82: Comparison between the static and adaptable systems for the statement "*I think that I would need assistance to be able to use this website*"

Question	Answers	Count/% within Group	Group: Static	Group: Adaptive	Total
I think that I would need assistance to be able to use this website	Disagree	Count	22	23	45
		% within Group	66.7%	69.7%	68.2%
	Agree	Count	11	10	21
		% within Group	33.3%	30.3%	31.8%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.070, df = 1, p = 0.79 (>0.05)					

I found the various functions in this website were well integrated. We have already seen that 51.5% of the static group participants agree, while 48.5% disagree. For the adaptive group, the corresponding proportions are exactly the same (see **Table 83**). There is no significant difference in the proportions with a chi-square value of 0.001, df of 1, and p = 0.1.00 (>0.05) (see **Table 83**).

Table 83: Comparison between the static and adaptable systems for the statement *"I found the various functions in this website were well integrated"*

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptive	
I found the various functions in this website were well integrated	Disagree	Count	16	16	32
		% within Group	48.5%	48.5%	48.5%
	Agree	Count	17	17	34
		% within Group	51.5%	51.5%	51.5%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.001, df = 1, p = 1.00 (>0.05)					

I thought there was too much inconsistency in this website. We have already seen that 48.5% of the static group participants agree with this statement while 51.5% disagree. For the adaptive group, the corresponding proportions are exactly the same (see **Table 84**) as for the last statement. There is no significant difference in the proportions with a chi-square value of 0.001, df of 1, and p = 1.00 (>0.05) (see **Table 84**).

Table 84: Comparison between the static and adaptable systems for the statement "*I thought there was too consistency in this website"*

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptive	
I thought there was too much inconsistency in this website.	Disagree	Count	17	17	34
		% within Group	51.5%	51.5%	51.5%
	Agree	Count	16	16	32
		% within Group	48.5%	48.5%	48.5%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-Square = 0.001, df = 1, p = 1.00 (>0.05)					

I would imagine that most people would learn to use this website very quickly. We have already seen that 48.5% of the static group participants agree with this statement while 51.5% disagree. For the adaptive group, the corresponding proportions are 48.5% and 51.5%, respectively (see **Table 85**). A slightly higher proportion of the adaptive group agree with the static group. However, there is no significant difference in the proportions with a chi-square value of 0.061, df of 1, and p = 0.81 (>0.05) (see **Table 85**).

Table 85: Comparison between the static and adaptable systems for the statement *"I would imagine that most people would learn to use the website quickly"*

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptive	
I would imagine that most people would learn to use this website very quickly	Disagree	Count	17	16	33
		% within Group	51.5%	48.5%	50.0%
	Agree	Count	16	17	33
		% within Group	48.5%	51.5%	50.0%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.061, df = 1, p = 0.81 (>0.05)					

I found this website very slow/awkward to use. We have already seen that 43.8% of the static group participants agree, while 56.3% disagree. For the adaptive group, the corresponding proportions are 46.9% and 53.1%, respectively. A higher proportion from the static group disagrees while a smaller proportion agrees compared to the adaptive group. This indicates that a slightly higher proportion of the participants disagree that the website for the static system is slow/awkward as compared to the proportion of participants to who disagree that the website of the adaptive system is slow/awkward. However, there is no significant difference in the proportions with a chi-square value of 0.063, df of 1, and p = 0.80 (>0.05) (see **Table 86**).

Table 86: Comparison between the static and adaptive systems for the statement *"I found this website very slow/awkward to use"*

Question	Answers	Count / % within Group	Group		Total
			Static	Adaptive	
I found this web-site very slow/awkward to use	Disagree	Count	18	17	35
		% within Group	56.3%	53.1%	54.7%
	Agree	Count	14	15	29
		% within Group	43.8%	46.9%	45.3%
Total		Count	32	32	64
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0., df = 1, *p* = 0.80 (>0.05)					

I felt very confident using this website. We have already seen that only 36.4% of the static group participants agree with this statement, while 63.6% disagree. For the adaptive group, the corresponding proportions are 45.5% and 54.5%, respectively. Compared to the adaptive group, a higher proportion from the static group disagrees while a smaller proportion agrees. This indicates that a higher proportion of the participants disagree that they felt confident using the static system website compared to the proportion of participants who felt confident using the adaptive system website. However, there is no significant difference in the proportions with a chi-square value of 0.56, df of 1, and $p = 0.45$ (>0.05) (see **Table 87**).

Table 87: Comparison between static and adaptive systems for the statement "*I felt very confident using this website*"

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptive	
I felt very confident using this website	Disagree	Count	21	18	39
		% within Group	63.6%	54.5%	59.1%
	Agree	Count	12	15	27
		% within Group	36.4%	45.5%	40.9%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.56, df = 1, *p* = 0.45 (>0.05)					

I needed to learn a lot of things before I could get going with this website. We have already seen that 60.6% of the static group participants agree with this statement, while 39.4% disagree. For the adaptive group, the corresponding proportions are 63.6% and 36.4%, respectively. Compared to the static group, higher proportions from the adaptive group agree while a smaller proportion disagrees. This indicates that a slightly higher proportion of the participants agree that they need to learn a lot before they get going with the adaptive system website as compared to the proportion of participants who need to learn a lot before they get going with the static system website. However, there is no significant difference in the proportions with a chi-square value of 0.064, df of 1, and $p = 0.80$ (>0.05) (see **Table 88**).

Table 88: Comparison between the static and adaptive systems for the statement *"I need to learn a lot of things before I could get going with this website"*

Question	Answers	Count/% within Group	Group: Static	Group: Adaptive	Total
I need to learn a lot of things before I could get going with this website	Disagree	Count	13	12	25
		% within Group	39.4%	36.4%	37.9%
	Agree	Count	20	21	41
		% within Group	60.6%	63.6%	62.1%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square=0.064, df = 1, $p = 0.80$ (>0.05)					

I felt the system helped me to study words and their meanings. We have already seen that 57.6% of the static group participants agree with this statement, while 42.4% disagree. For the adaptive group, the corresponding proportions are 57.6% and 42.4%, respectively—the exact same proportions. There is no significant difference in the proportions, with a chi-square value of 0.001, df of 1, and $p = 1.00$ (>0.05), (see **Table 89**).

Table 89: Comparison between the static and adaptive systems for the statement *"I felt the system helped me to study words and their meanings"*

Question	Answers	Count/% within Group	Group: Static	Group: Adaptive	Total
I felt the system help me to study words and their meanings	Disagree	Count	14	14	28
		% within Group	42.4%	42.4%	42.4%
	Agree	Count	19	19	38
		% within Group	57.6%	57.6%	57.6%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0.001, df = 1, $p = 1.00$ (>0.05)					

I think that I would need assistance to be able to learn words. We have already seen that only 27.3% of the static group participants agree with this statement, while 72.7% disagree. For the adaptive group, the corresponding proportions are 30.3% and 69.7%, respectively. Compared to the adaptive group, a higher proportion from the static group disagrees while a smaller proportion agrees. This indicates that a slightly higher proportion of the participants disagree that they need assistance with the static system to be able to learn words compared to the adaptive system website. However, there is no significant difference in the proportions with a chi-square value of 0.074, df of 1, and $p = 0.79$ (>0.05) (**Table 90**).

Table 90: Comparison between the static and adaptive systems for the statement *"I think that I would need assistance to be able to learn words"*

Question	Answers	Count/% within Group	Group		Total
			Static	Adaptive	
I think that I would need assistance to be able to learn words	Disagree	Count	24	23	47
		% within Group	72.7%	69.7%	71.2%
	Agree	Count	9	10	19
		% within Group	27.3%	30.3%	28.8%
Total		Count	33	33	66
		% within Group	100.0%	100.0%	100.0%
Chi-square = 0., df = 1, $p = 0.79$ (>0.05)					

5.29 Summary of Comparison between Static and Adaptive System for Each Statement

As the researchers have discussed above, there is no statistically significant difference in any of the 12 statements regarding the static and adaptive systems as evaluated by the participants.

5.30 Overall Picture: Static vs. Adaptive System

With respect to the static vs. adaptable systems, there is a desire to understand the overall picture between the static and adaptive systems. The same method as before is used here. Descriptive statistics for the 12 statements regarding static and adaptive systems are shown in **Table 91**.

Table 91: Descriptive statistics for all 12 statements regarding static and adaptive systems

	Group					
	Static			Adaptive		
Statement	Mean	Std. Deviation	Median	Mean	Std. Deviation	Median
I think that I would like to use this website frequently.	3.30	2.01	5.00	3.33	1.73	4.00
I found this website unnecessarily complex.	2.67	1.93	1.00	2.63	1.62	2.00
I thought this website was easy to use.	2.76	1.97	1.00	2.88	1.67	2.00
I think that I would need assistance to be able to use this website.	3.79	1.76	5.00	3.70	1.61	4.00
I found the various functions in this website were well integrated.	3.00	1.98	4.00	3.06	1.78	4.00
I thought there was too much inconsistency in this website.	3.09	2.01	5.00	3.03	1.70	4.00
I would imagine that most people would learn to use this website very quickly.	2.85	1.95	1.00	2.97	1.86	4.00
I found this website very slow/awkward to use.	3.38	1.90	5.00	3.13	1.66	4.00
I felt very confident using this website.	2.42	1.92	1.00	2.79	1.75	2.00
I needed to learn a lot of things before I could get going with this website	2.67	1.93	1.00	2.67	1.61	2.00
I felt the system helped me to study words and their meanings.	3.30	2.01	5.00	3.33	1.67	4.00
I think that I would need assistance to be able to learn words.	3.94	1.77	5.00	3.85	1.62	5.00
Usability	3.09	0.68	3.00	3.11	0.59	3.08

The means (averages) and medians for each statement, and for the overall, show that there are not many differences between the two systems. **Figure 23** shows the over usability between the two systems.

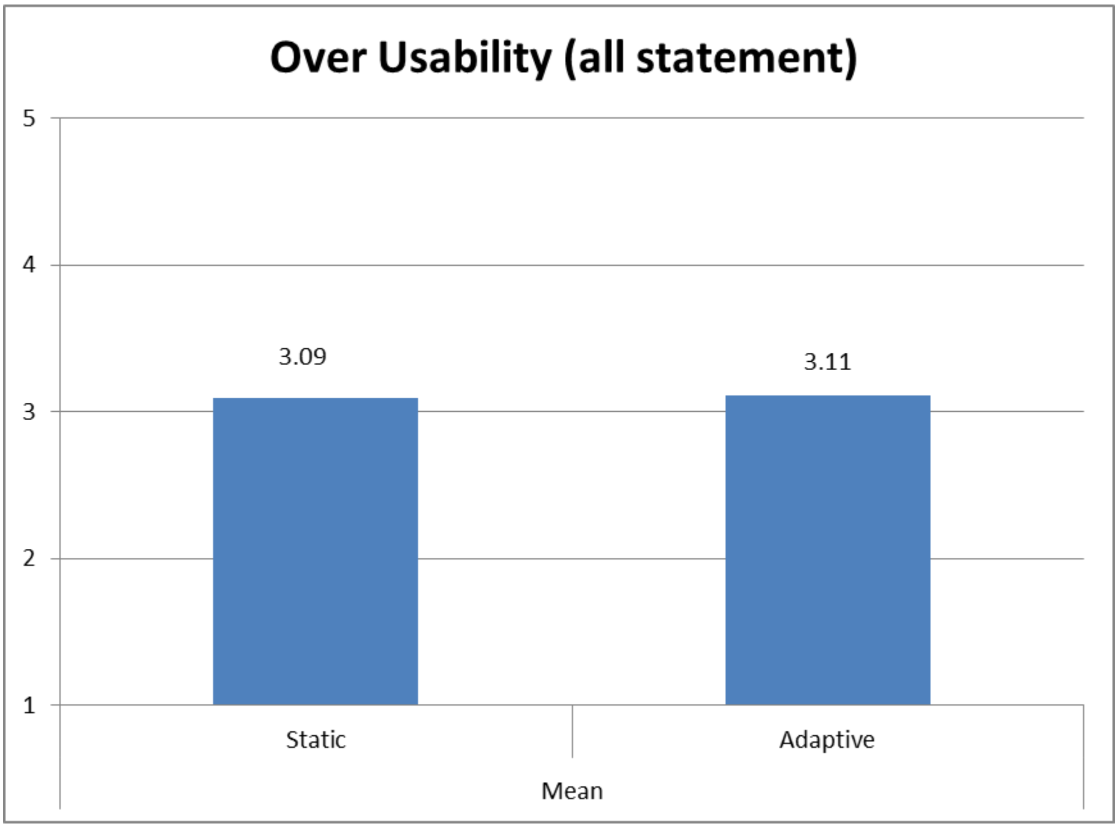

Figure 23: Overall usability (all statements) between static and adaptive systems

5.31 Average Time for each Task: Static vs. Adaptive

Descriptive statistics for the average time for each task between the static and adaptive systems are shown in **Table 92**. The adaptive system has a lower mean time (173.61) compared to the mean time for the static system (180.73).

Table 92: Descriptive statistics for average time (in seconds) for each task for static vs adaptive systems.

Group	Mean	Std. Deviation	Median
Static	180.73	30.64	175.00
Adaptive	173.61	28.45	170.00
Total	177.17	29.56	175.00

5.32 Total Average Score (Learnability) between Static and Adaptive Systems

To compare how easy it is to learn from each system, the researcher obtained an average total score for each participant. The scores are used to assess each system's learnability. Summary statistics of the average total score by group is shown in **Ta-**

ble 93. On average, the participants using the static system achieved a lower score compared to the participants using the adaptive system. Also, the static group median value was lower than that of the adaptive group, as shown in **Figure 24**. This may indicate that the participants using the adaptive system learned more than those using the static system.

Table 93: Summary statistics total average score for static and adaptive systems

Group	Mean	Median	Mode	Std. Deviation	Minimum	Maximum
Static	45.52	45.00	40.00	15.04	20.00	70.00
Adaptive	61.48	65.00	70.00	12.21	36.00	80.00

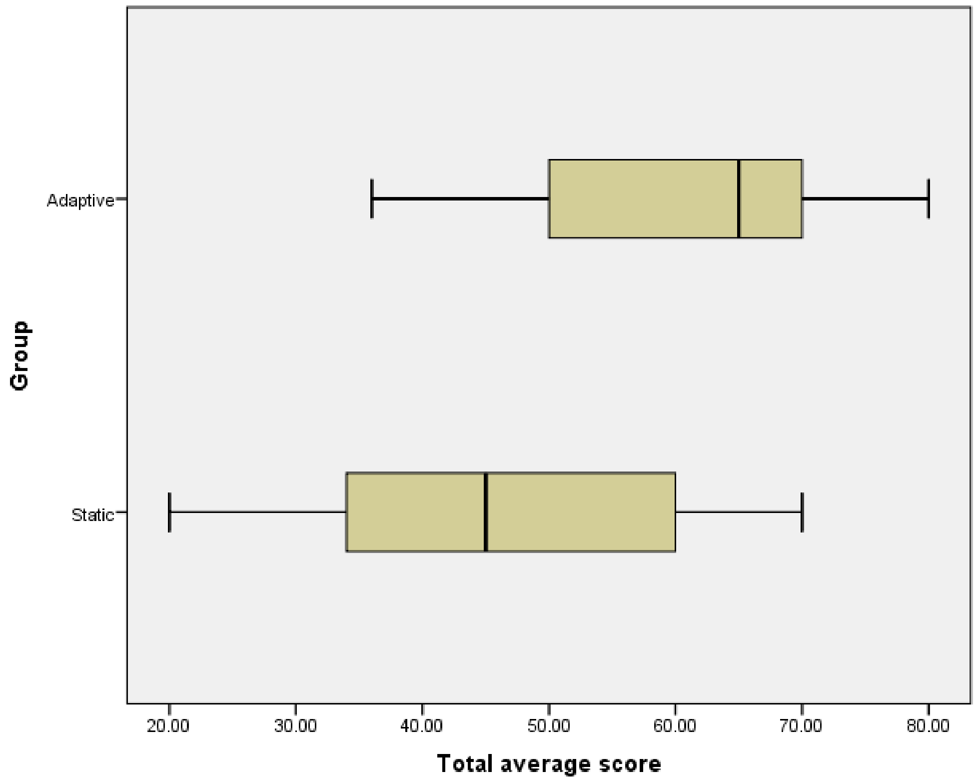

Figure 24: Median score of learnability between the static and adaptive groups

The results of the Mann-Whitney U test are shown in **Table 94**. The mean rank for the static group was 23.85, while that for the adaptive group was higher (43.15); there was a statistically significant difference between the mean ranks with a Mann-Whitney U value of 266.00 and a *p*-value of 0.001 (<0.05). This indicates that participants using the adaptive system achieved significantly higher scores than participants using the static system. There is higher learnability on the adaptive system compared to the static system.

Table 94: Comparison between static and adaptive groups on total average score

Group	N	Mean Rank	Mann-Whitney U	*p*-value
Static	33	23.85	266.00	0.001
Adaptive	33	43.15		

5.33 Conclusion: Static vs. Adaptive Systems

There is no difference in usability between the static and adaptable systems at the overall level and at the individual statements level. However, there is a difference in learnability, which is higher when using the adaptive system as compared to the static system. The SUS score was normally distributed and the variances between the three groups were equal (see **Table 95**), so the **ANOVA** test was used to determine if any differences existed in SUS score across the three groups.

Table 95: Normality and homogeneity of variance tests

Group	Tests of Normality			Test of Homogeneity of Variances	
	Shapiro-Wilk			Levene Statistic	*p*-value
	Statistic	df	*p*-value		
Static	0.96	33	0.20	0.249	0.78
Adaptable	0.97	33	0.51		
Adaptive	0.98	33	0.90		

Descriptive statistics for the three systems are shown in **Table 96**. The mean SUS scores for the three systems were very close, as shown in the table. The **ANOVA** test also showed that there was no significant difference in the SUS score across the three systems with an F value = 0.014 and p = 0.98 (>0.05).

Table 96: Descriptive statistics for the SUS score for all three systems

System	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Static	33	25.24	8.03	1.40	22.40	28.09	4.00	42.00
Adaptable	33	25.45	7.88	1.37	22.66	28.25	4.00	42.00
Adaptive	33	25.55	7.04	1.22	23.05	28.04	7.00	41.00
Total	99	25.41	7.58	0.76	23.90	26.93	4.00	42.00

Using SUS scores, the researcher learned that there is no significant difference in the three systems. The participants found all three systems similar. This conclusion is the same as before using the chi-square and Mann-Whitney tests.

5.34 Potential benefit in practise

The principal benefit of adaptation in graphical user interface is to improve the quality of software to users concern and needs. Usability metrics provides measurements to enhance great outcome of system qualities. This research succinctly can be concluded that it is important considering this experimental programme and the significant results were carried out and found in the complex vocabulary learning tasks. Adaptation can be considered depending upon the complexity of vocabulary and level of adapted techniques depends on users need. Questions such when and where are important on learning vocabularies. User challenging (time) in learning tasks indicate that more time spent on learning exceeding the level on normal and mistakes occurred give impression that level of adaptation must be cope users need and learn. Significant results were usable and acceptable in adaptive platform, where medium learning vocabularies results were more usable and acceptable that other platforms. Overall, it can be seen that sub-hypothesis related to usability study were accepted, whereas was rejected. It can be said that there is at least 95% probability that user's ability to learn more effectively and efficiently resulted from adapting vocabulary learning interface depending on the level of vocabulary complexity. This study can be generalised to Arabian speaker, but not to any other language, that fact is culture and language stricture must be taken in to account.

5.35 Summary

The aim of this study to explore and document the role of adaptation in enhancing vocabulary learning, and to investigate efficiency, effectiveness, and satisfaction levels after adaptation is used. Observations were conducted to understand the natural effects of adaptation on graphical user interfaces (GUI) and on the interaction of learning vocabulary and enhancing learnability. For each of these elements, usability measures were applied and tested in order to satisfy the above aim. The results of this empirical experimental study helped to answer the research questions stated in Section 1.6. The starting point of this investigative vocabulary survey involved collecting and determining word levels of difficulties from Saudi Arabian students' perspective. Then, an experiment was carried out to explore and examine appropriate learning and personalised approaches. Far too little attention has been paid to comparing adaptable (user and selection), adaptive (system use and selection), and mixed-initiative (combination of system and user) approaches. In this study, the metrics used to measure efficiency were task accomplishment time and frequency-of-error occurrence, while effectiveness was measured by calculating the number of subjects completing all tasks and the number of tasks completed successfully within task criteria times. Satisfaction was measured by using 6-point Likert scales. The results of this study provided encouraging evidence that each approach has advantages and disadvantages.

The adaptation of a GUI in this thesis with its adaptation type the adaptable, adaptive, and mixed-initiative approaches have different levels of decision making, these experiments were conducted to address questions about adaptability and adaptivity levels, and learn how to mix them at some levels. For example, how much of a level of control (by percentage) is needed for users who use the adaptive, adaptable, and mixed-initiative approaches? More specifically, is this enough control to easily perform tasks? Therefore, we asked these questions after subjects had performed each task level (easy, medium, and complex), and also at the end of the experiment. In addition, the experimental results were obtained from both quantitative and qualitative measures and observed data. The interview was conducted with the subjects during the pilot study. The results indicate that providing more information and static evidence required understanding each approach and the user's needs. This should provide a feeling of greater control for subjects who used the adaptable approach. The aim of this experiment was to discover which personalised approach users preferred. In addition, the researchers were interested in the impact of personalisation approaches on the online learning environment. This means that providing more or less control than what users expected and needed reduced satisfaction levels. In addition, the results show that subjects performed their tasks with less effort in the mixed-initiative condition than in any other condition.

This section has described the initial comparative evaluation of adaptation types' static, adaptive, adaptable, and mixed-initiative approaches to online learning vocabularies for non-English speakers. The results indicate that, overall, there was a significant difference between the various approaches in usability parameters (efficiency, effectiveness, and satisfaction). These differences are critical because they can motivate and enhance language learning. The overall results indicate that subjects perform better with the mixed-initiative condition over the other three in terms of difficult vocabularies. Further investigation is required to learn more about the nature of adaptation in other languages due to the relationship of language with users' behaviour. This section has attempted to answer research questions Q3, Q4, and Q5 presented in Section 1.6. The aim of this study was to give details of descriptive analysis and comparison between different approaches.

Table 97: Review of overall hypothesis acceptance and rejection status to usability

Hypothesis Overall Hypothesis	Accepted	Rejected	Probability	Reference
(a) System Efficiency				
(a.1) Learning vocabularies in the adaptable system was more effi-	√		95%	Section 5.11.1

cient than in the static system				
(a.2) Learning vocabularies in the adaptive system was more efficient than in the static system	√		95%	Section 5.11.2
(a.3) Learning vocabularies in the adaptable system was more efficient than in the adaptive system		√	95%	Section 5.11.3
(b) System Effectiveness				
(b.1) Learning vocabularies in the adaptable system was more effective than in the static system	√		95%	Table 28 p.132
(b.2) Learning vocabularies in adaptable system was more effective than in the static system	√		95%	Table 28 p.132
(b.3) Learning vocabularies in the adaptive system was more effective than in the adaptable system	√		95%	Table 28 p.132
(b.4) Learning antonyms' vocabularies was more effective than learning synonyms	√		95%	Table 28 p.132
(c) System Efficiency				
(c.1) Learning vocabularies in the mixed-initiative system was more efficient than in the static system	√		95%	Section 5.11.7 Table 35 p.143
(d) System Effectiveness				
(d.1) Learning vocabularies in the mixed-initiative system was more effective than in the static system	√		95%	Section 5.11.9 Table 37 p.144
(d.2) Learning vocabularies in the adaptable system was more effective than in the mixed-initiative system	√		95%	Section 5.11.9 Table 37 p.144
(d.3) Learning vocabularies in the mixed-initiative system was	√		95%	Section 5.11.9 Table 37 p.144

more effective than in the adaptive system				
(d.4) Learning antonyms vocabularies in the mixed-initiative system was more effective than	√		95%	Section 5.11.9 Table 37 p.144
(d.5) Learning synonym vocabularies in the mixed-initiative system were more effective.	√		95%	Section 5.11.9 Table 37 p.144
(e) The ability to achieve test results				
(e.1) Learning vocabulary test results in the adaptable system were more effective.	√		95%	Section 5.12.3 Fig 19 p.151

A usability study was designed to address the primary aim of comparing the usability of static, adaptive, adaptable, and mixed-initiative approaches in terms of effectiveness and efficiency of system use in the learning of Web content. The results show that subjects did slightly well with difficult vocabularies in the three approaches, while the mixed-initiative approach provided good achievement test results. Addressing the hypotheses posed at the beginning of this study and the findings, it is now possible to state the following conclusions.

Table 97 reviews assumption with the probability level of overall research usability. The overall hypothesis stated that:

The evaluation of the adaptation application of controllability experience gained from commercial websites, from Amazon to educational websites, explores how system-driven personalisation enhances the interaction of Web-based learning allocation.

Improvement in learning vocabulary was sought in usability areas; learning from different platforms was encouraging. Each approach has statistically sufficient results which indicate that there was learning improvement in terms of level of difficulty. In general, the adaptive learning approach provided surprisingly better learning in antonyms and synonyms in terms of efficiency than learning conducted between the four systems (static, adaptable, adaptive, and mixed-initiative) with two methods of learn-ng antonyms and synonyms. For the subjects who completed all tasks with the best performances, the methods were as follows: for easy learning, the adaptable system was most effective; for moderate learning, the mixed-initiative system was most effective; for difficult learning, the adaptable system was most effective; and for both antonyms and synonyms, the adaptive system was most effective. The static system was excluded from the comparison of antonyms and synonyms. As a result, the adaptive system was the most effective for learning antonyms and synonyms, and the adaptable system was better for both easy learning and difficult learning. The mixed-initiative system was conducted separately because the technique was combined between the three systems, but it was compared in this research (see Section 5.10.4).

For system effectiveness, the measurements were conducted on four platforms. Of the subjects who completed all tasks, the highest performance was for those using the adaptive system; also, the number of tasks completed was highest in the adaptive system. This leads us to conclude that in the static system, the overall percentage for those completing all tasks was, respectively, 78% for static, 81% for adaptable, and 86% for adaptive. The percentages for tasks completed successfully were 58% for static, 75% for adaptable and 75.3% for adaptive (see Section 5.10.4).

With regard to satisfaction, the static approach and the minimised approach, on the second use (see Section 5.10) and on average learning vocabulary time, the student took 5.02s to learn an easy vocabulary word using the static system, 9.92s to learn a moderate vocabulary word using the adaptable system, and 13.51s to learn a difficult vocabulary word using the adaptive system, while it took an average of 12.77s in the static system to examine and recall easy vocabulary, 13.61s in the adaptable system to examine and recall moderate vocabulary, and 13.62s in the static system to examine and recall difficult vocabulary. The error rate was 2.0% in the static system and 1.90% in the adaptable and adaptive systems. While 0.20% in the static system, no error occurred in either the adaptable and adaptive systems (see Section 4.7.4).

Chapter 6: Conclusions and Empirically Derived Guidelines

6.1 Introduction

The final chapter of this thesis summarises the work that has been done and the results achieved. The approach taken in this thesis involved the comparison of adaptations with the static approach in terms of usability.

6.2 Limitations

The work presented in this thesis has a couple of limitations, which are briefly described below and linked to future work.

6.2.1 The Ability to Learn Vocabulary

The key element in learning vocabulary is the ability to assimilate and apply the right knowledge effectively. Achieving vocabulary is meant to be by learning[279]. The study was conducted online and, as with any such experiment, there were some limitations. The ability to memorise differs from one person to person and basing was considered with attempting to be limited as possible. These experiments were done in a short period of time; the results might have been different over a longer period. Furthermore, these experiments tested Web content and GUIs in very specific systems and environments. The most difficult question is how to generalise these results to other environments. Adaptivity, adaptability, and mixed-initiative techniques were used. Adaptability was dependent on user suggestion; adaptivity was dependent on the easiness of the customised interface; and mixed-initiative was dependent on mitigating all of these techniques for use as better learning sets.

6.2.2 Sampling Size and Snapshots

The experiments were performed with small samples, as stated in the formula in Section. The findings in this thesis provide a snapshot image of user performance. This may not be catered to other nations because of cultural issues and users' abilities.

6.2.3 Guidelines

The guidelines produced in Chapter are based on the experiments performed and should not be universally applied in all languages. These guidelines provide a general direction for motivating learners and the suitability of online learning and designers. Designers may need to make their interpretations in their own language online learning experiences. However, the research clearly pointed out that each approach has its own weaknesses and strengths, as stated in the results.

6.3 Revising Original Contributions

The main contribution of this thesis is the examination of the efficiency, effectiveness, and user satisfaction of three personalised approaches (adaptable, adaptive, and mixed-initiative) to learning English vocabulary and elaborating usability and learning within online learning vocabulary environments for non-English speakers. An additional goal is to mitigate and examine the use of each approach empirically, driving some guidelines and suggestions in the finding.

To fulfil the research aim, each approach was examined and compared to the static approach, and finally compared to the mixed-initiative approach in terms of personalised Web content and GUI.

6.4 Empirically Derived Guidelines

The hypotheses posed at the beginning of this thesis was tested, and it is now possible to offer empirically derived guidelines intended to increase the usability of personalised content and enhance learning interaction between users and applications. This section derives a number of usability guidelines that can be used to design more usable personalised interfaces. Results are presented in order to assist designers and individual users in deciding whether to use interaction with adaptation (such as static, adaptive, adaptable, and mixed-initiative) in personalising and learning Web content and GUIs. The following guidelines are linked to the results obtained, which helps us to draw conclusions and provide more helpful advice to designers. These empirical guidelines are presented in four subcategories.

6.4.1 Designing a Learning-Difficult-Vocabulary Interaction

The experiments in this thesis suggest that designers need to consider the different characteristics of personalisation approaches. They must consider that learning by antonyms and synonyms was more advisable with the mixed-initiative approach.

6.4.2 Adaptability Usage in Learning

The main objective of this study was to see the differences between learning platforms in terms of learning vocabularies. Using the adaptable technique on easy, moderate, and difficult vocabulary compared with the static approach showed a significance level (see Section 5.11.1.1) with an effect towards learning. Also, it showed a level of significance compared with the adaptive approach in moderate and difficult learning (see Section 5.11.3.1). In terms of error rates, it showed the lowest error level compared to other platforms, with a sum of 25 (see Section 5.11.4). The effect level of participating in managing the mixed-initiative approach was 34% of the system process usage.

6.4.3 Adaptivity Usage in Learning

The second level involved investigating the effect in adaptation in the adaptive approach to learning vocabulary. There was a level of significance in easy, moderate learning only when compared with the static platform (see Section 5.11.2), while there was significance in learning difficult vocabulary and the level of the error rate (section 5.11.4). Also, learning difficult vocabularies on this level as compared with the mixed-initiative platform led to more effective learning (see Section 5.11.5.1). The effectiveness of performing antonyms and synonyms was high (86% and 100%)

(See Section 5.11.5.1). This learning performance showed the effectiveness of this technique.

6.4.4 Mixed-Initiative Usage in Learning

There is a great opportunity for researchers and designers to consider the use of the mixed-initiative approach because of the ability to manipulate different techniques of GUI in one direct approach. The approach gained a great deal of trimming and the automation that it holds. Direct comparison showed significant results between the mixed-initiative and adaptable or adaptive methods; different areas, such as menus, agents but rare in learning. The recommendation was to use this approach because it tends to improve usability by providing different techniques for the best system use. The findings suggest that this approach is recommended experimentally for future investigation. The effect of other approaches compared to the mixed-initiative system is as follows: the static system by 29%, adaptable approach by 41%, adaptive approach by 29%, antonyms technique by 54%, and synonym by 38% (see Section 5.12.9). Therefore, the following issue will need to be addressed in the future:

- Learner unaware of the technique; therefore, user notification is suggested to use earcons to solve the problem. The fact is jumping by learning by meaning and antonyms and different features will confuse the learning to achieve the learning goal.

6.5 Lessons Learnt

Throughout this study, many lessons were learnt. The most important are listed in the sections below.

6.5.1 Making Knowledge Work

- To discover new ideas and make them work, researchers need to investigate by reading, asking questions, and writing notes on the work of other researchers.

- Time is important, and managing that time is extremely important. It might be more important than the time itself. It produces control and management.

6.5.2 Pilot Testing

- Pilot testing is a good method for saving time and effort in research by examining the proposed hypotheses and reducing the number of problems. The main benefit of a pilot test is that it gives the researcher a chance to examine new ideas, approaches, and clues.

- Most of the measurements from pilot testing give the experimenter the criterion time and its standardised focal point.

- Pilot testing is required to carefully observe both the system and the user's behaviour, and then to note it. In addition, a pilot test gives brief and quick feedback about the environment and how users would normally react while using the systems being examined. From pilot testing, 50 vocabularies were tested by the system; during that time, all users were frustrated and not able to complete the testing. It has been reduced to 40 vocabularies after testing.

6.5.3 Experiment Reliability and Data Validity

Different methods, designs, and approaches can be used to conduct an experiment. The analysis of the results can also be tested statistically in a number of ways. Therefore, the research method should be decided at an early stage to ensure that the experiment is evaluated and to consider reliability and validity [280, 281]. However, validity refers to measuring how well the instrument measures what is supposed to be measured, while reliability refers to consistency or the solidity of the instruments. Consistency is very important to control the experiment and to limit any effects on the experiment's goals. For example, any IVs need to be controlled during the experiment to ensure consistency. However, selecting the correct number of users is a critical issue in the research field because of the debate regarding picking up the right number of user needs, so some researchers argue that 8 to 12 users is ideal, while others believe there should be more. Following this debate, a decision was made to stay within this range because the experiment must be controlled and manageable to ensure its consistency. In addition, the researcher found that comparing two systems required the tasks and content of these two conditions to be equal to ensure experimental consistency.

6.6 Directions for Future Research

In the mixed-initiative approach, control is based on the system depending on each vocabulary and learning achievement. Evaluation of this interaction has received little attention in the research literature. One could examine when and how much initiative the system should take to provide users with support with technical terms. Therefore, the balance of initiative between users and the system should be carefully examined. It may be, for example, that users find systems which take more initiative to be annoying. In addition, it would be valuable to explore how often users need suggestions while performing their tasks.

6.7 Epilogue

The work in this thesis has demonstrated empirically how usability in different environments affects and expands language learning. The summary, the results, and the outcome of this thesis will provide researchers and designers with insight into the problem facing those learning the language and the use of GUI adaptation to enhance the learning of the English language for non-English speakers.

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Appendices

Appendix A: Questionnaire

We are investigating the use of different software interaction learning approaches and we would like to obtain your views about the use of such interactions. We compared between four conditions: Static, Customised, Personalised, and Mixed Initiative (for more explanation, see the terminology). Each was implemented in separate systems.

Please follow the procedure bellow:

Answer Part 1 the pre-session questionnaire.

1. In Part 2, read each vocabulary word and try to memorise, then answer, the next questions carefully.
2. Start the task.
3. On completion of the tasks, answer the questions provided in Part 5.
4. On completion of the tasks, answer the questions provided.
5. For customisation and mixed-initiative procedure provided at the end of this document.

Terminology

- **Static**: The interface and content do not change over time.
- **Customisation**: The interface and content change over time by user.
- **Personalisation**: The interface and content change over time by system.
- **Mixed-initiative**: The interface and content change over time by user and system.

I would be grateful if you could fill in the following questionnaire truthfully and provide your views. Thank you for your participation.

Alshumari Mansour

Part 1 SUS Questionnaire

SUS is a Likert scale simply depend on forced choice questions, where a statement is made and represent then indicates the degree of user agreement or disagreement with the statement on 5 point scales.

System Usability Scale

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Appendix B

Appendix B: Screenshot for all the system

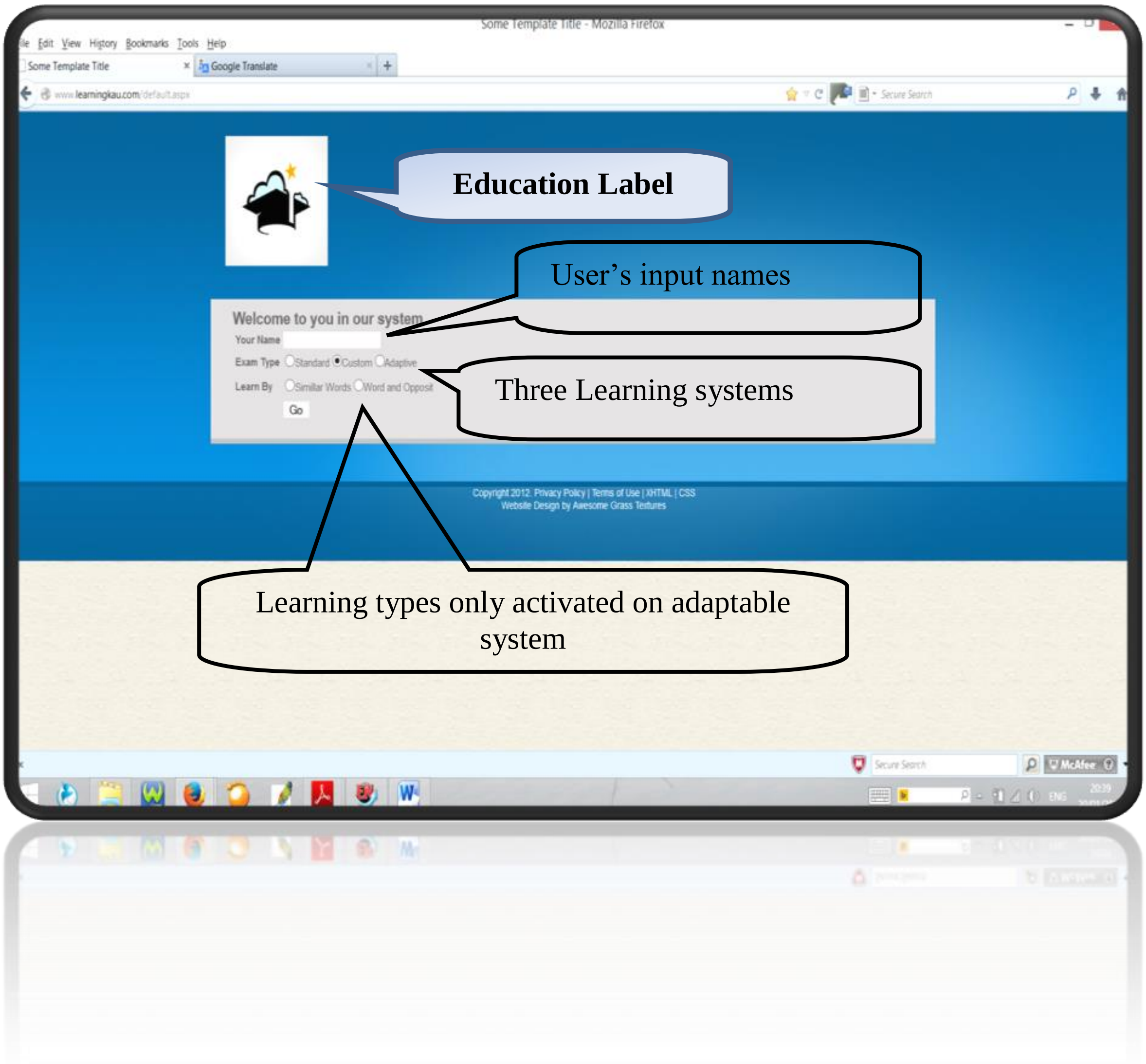


Figure 25: Adaptable learning system style

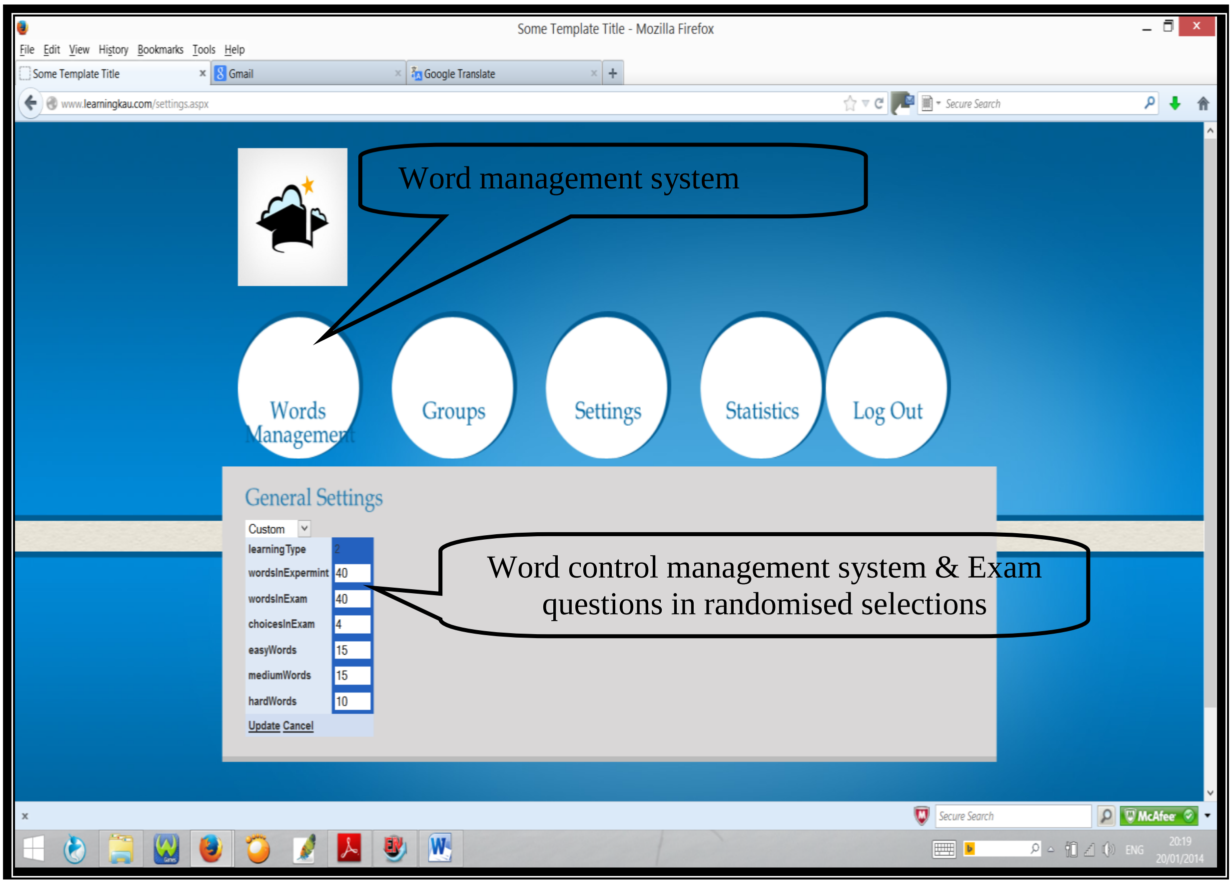


Figure 26: Adaptable word setting

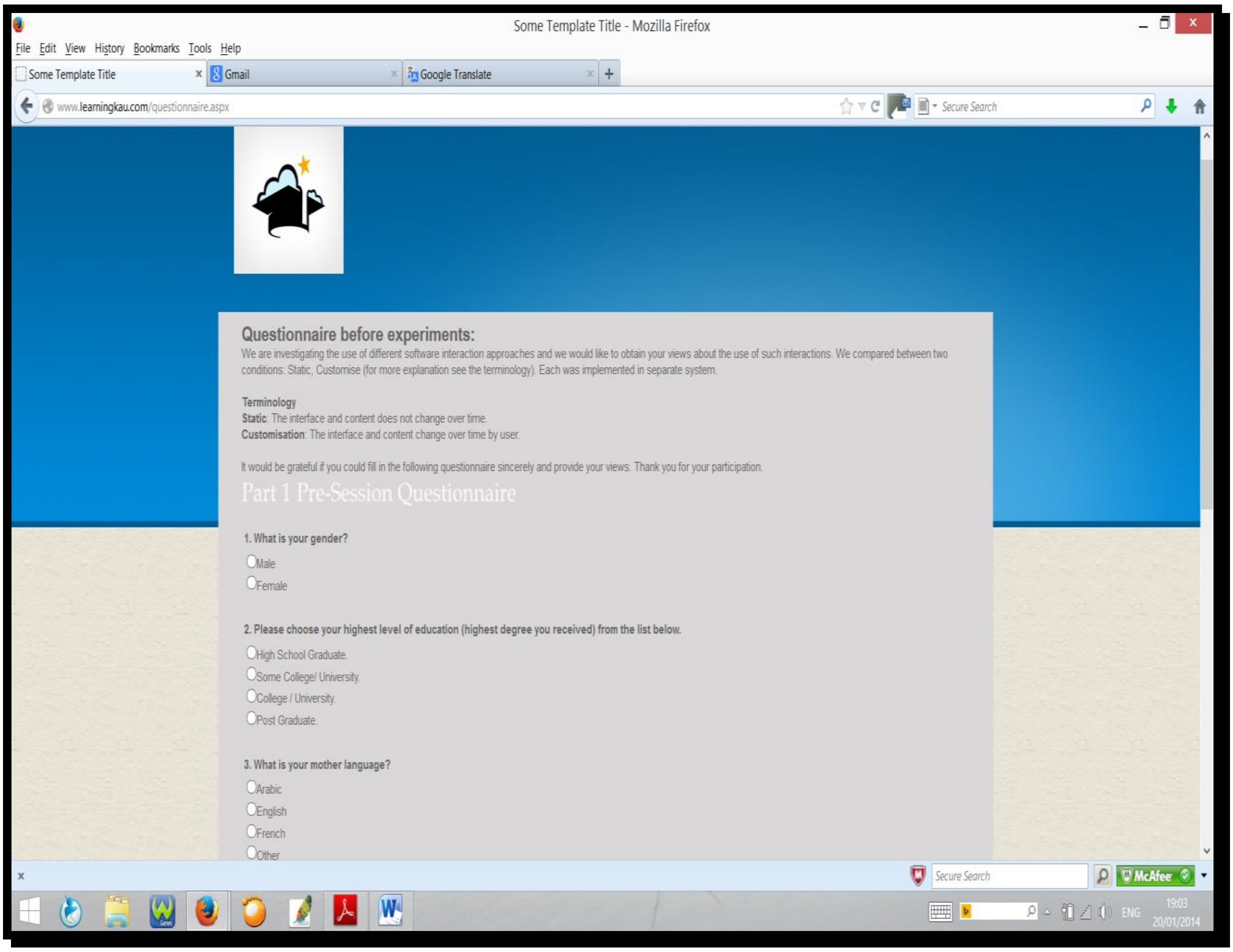


Figure 27: Adaptive user questionnaire

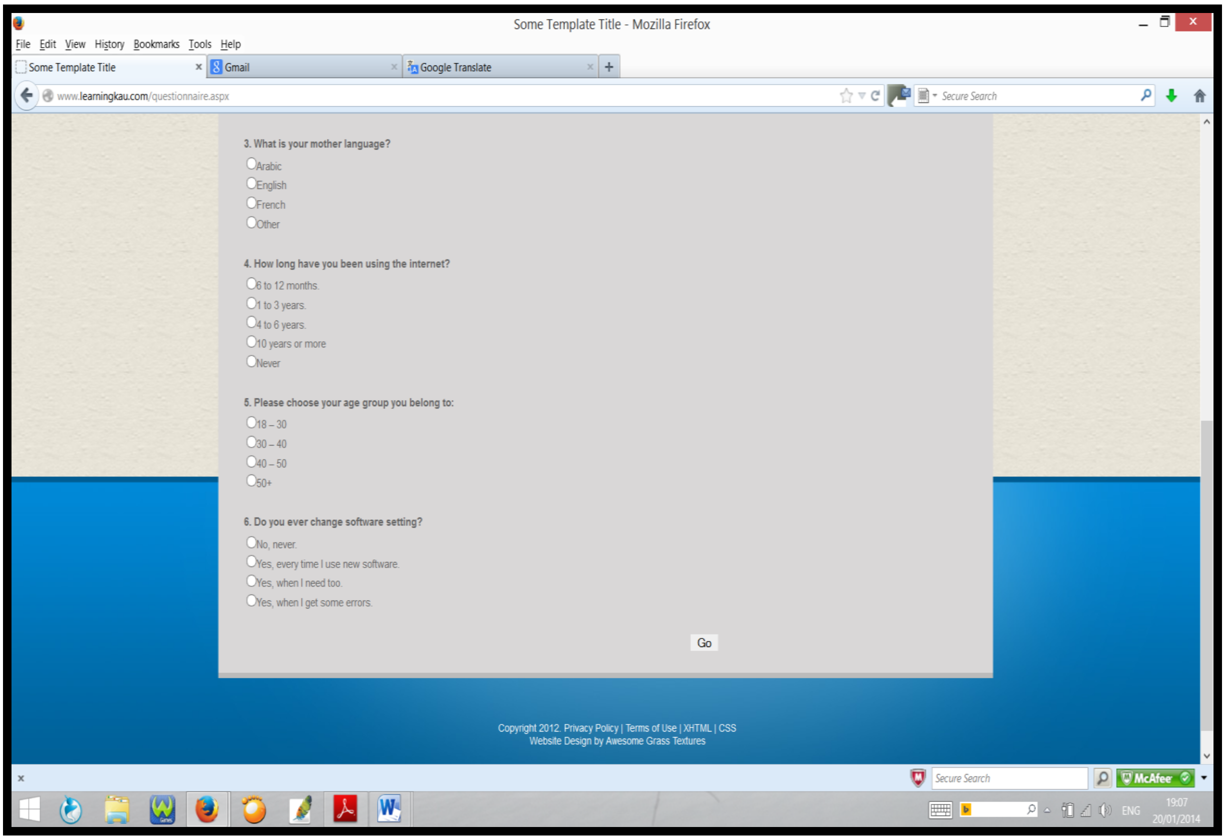


Figure 28: Adaptive user questionnaire continuation

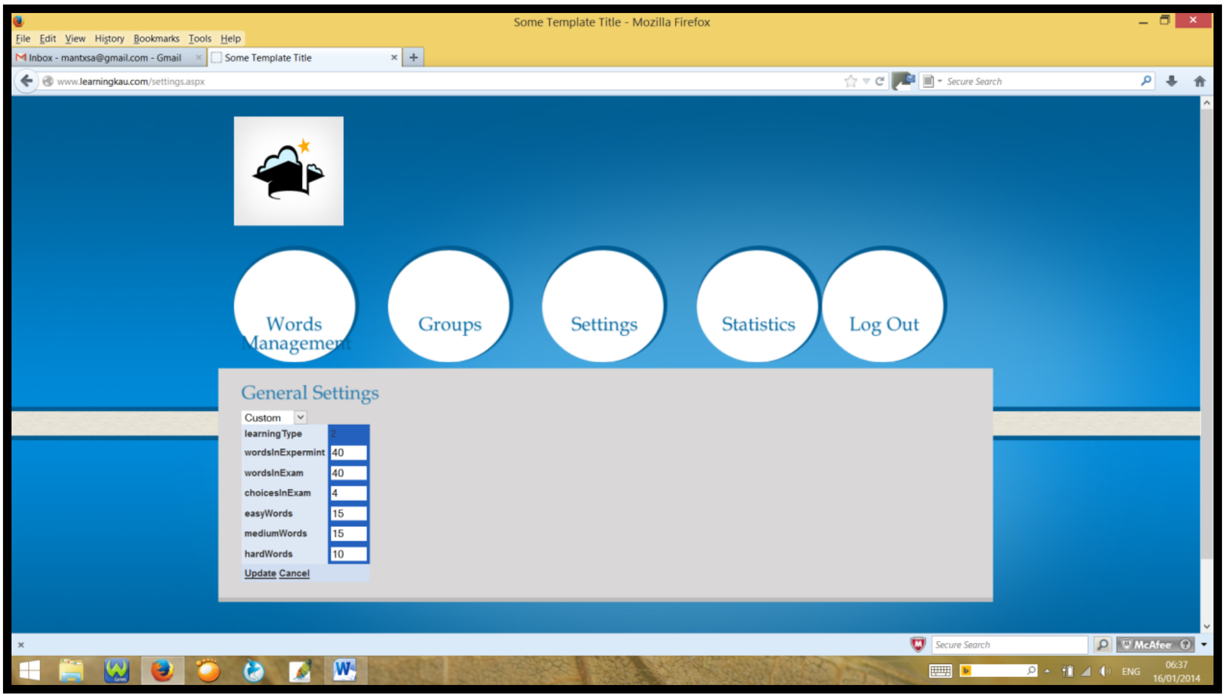


Figure 29: Adaptable setting control

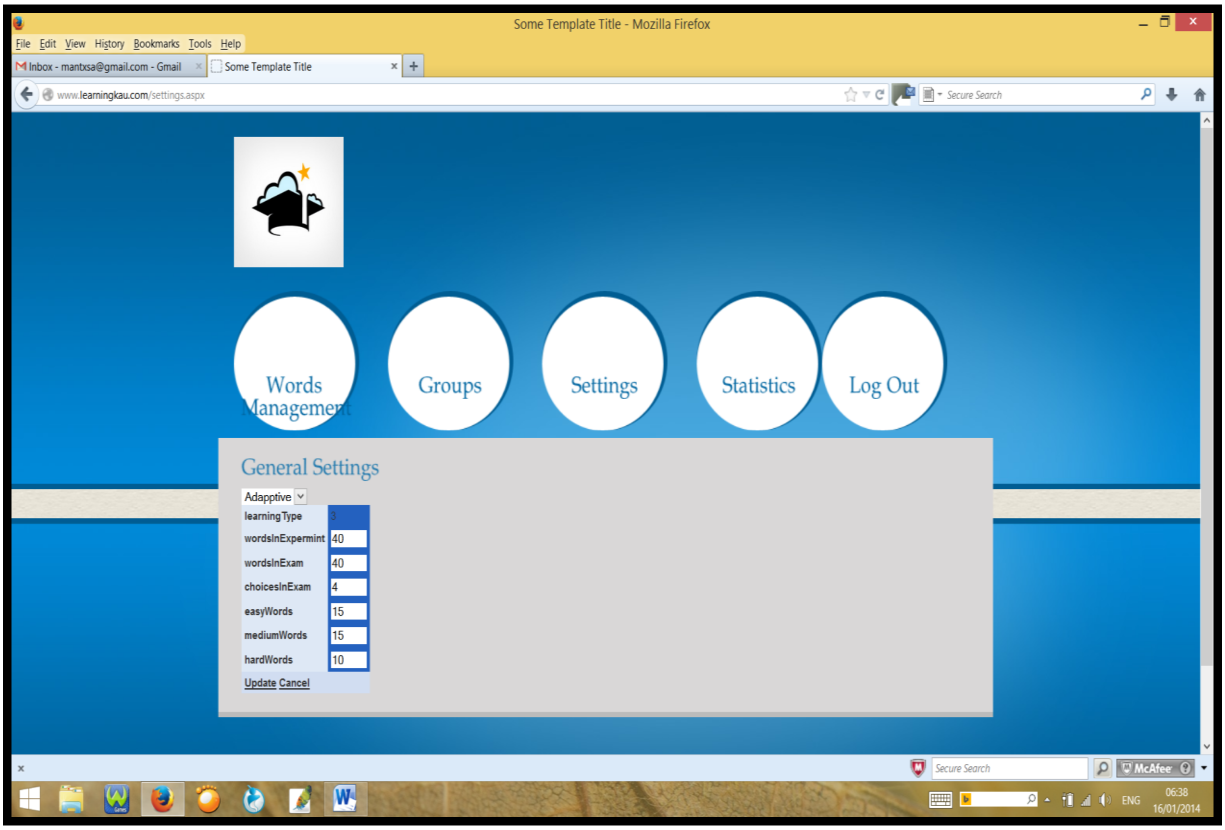


Figure 30: Adaptive setting control

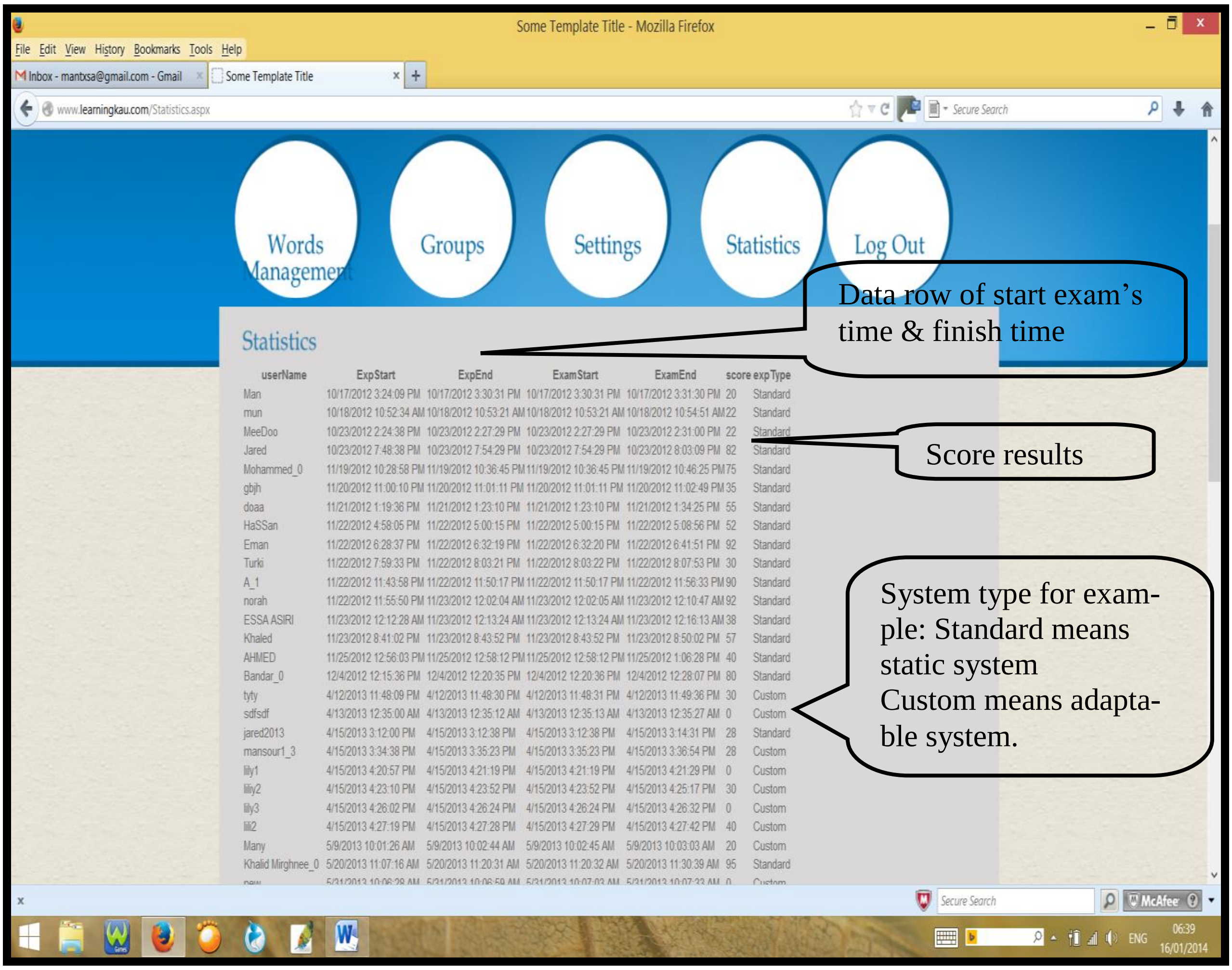
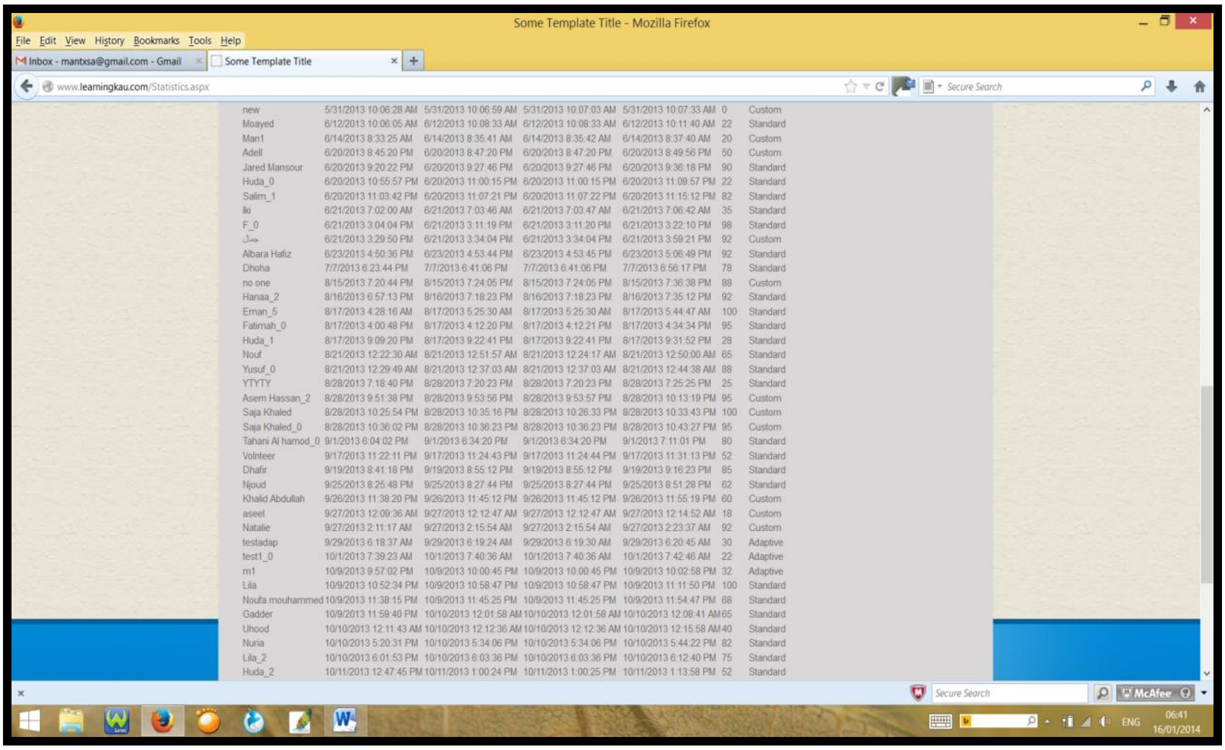


Figure 31: Data statistics combine view



new	5/31/2013 10:06:28 AM	5/31/2013 10:06:59 AM	5/31/2013 10:07:03 AM	5/31/2013 10:07:33 AM	0	Custom
Moayed	6/12/2013 10:06:05 AM	6/12/2013 10:08:33 AM	6/12/2013 10:08:33 AM	6/12/2013 10:11:40 AM	22	Standard
Man1	6/14/2013 8:33:25 AM	6/14/2013 8:35:41 AM	6/14/2013 8:35:42 AM	6/14/2013 8:37:40 AM	20	Custom
Adell	6/20/2013 8:45:20 PM	6/20/2013 8:47:20 PM	6/20/2013 8:47:20 PM	6/20/2013 8:49:56 PM	50	Custom
Jared Mansour	6/20/2013 9:20:22 PM	6/20/2013 9:27:46 PM	6/20/2013 9:27:46 PM	6/20/2013 9:36:18 PM	90	Standard
Huda_0	6/20/2013 10:55:57 PM	6/20/2013 11:00:15 PM	6/20/2013 11:00:15 PM	6/20/2013 11:09:57 PM	22	Standard
Salim_1	6/20/2013 11:03:42 PM	6/20/2013 11:07:21 PM	6/20/2013 11:07:22 PM	6/20/2013 11:15:12 PM	82	Standard
lki	6/21/2013 7:02:00 AM	6/21/2013 7:03:46 AM	6/21/2013 7:03:47 AM	6/21/2013 7:06:42 AM	35	Standard
F_0	6/21/2013 3:04:04 PM	6/21/2013 3:11:19 PM	6/21/2013 3:11:20 PM	6/21/2013 3:22:10 PM	98	Standard
جمل	6/21/2013 3:29:50 PM	6/21/2013 3:34:04 PM	6/21/2013 3:34:04 PM	6/21/2013 3:59:21 PM	92	Custom
Albara Hafiz	6/23/2013 4:50:36 PM	6/23/2013 4:53:44 PM	6/23/2013 4:53:45 PM	6/23/2013 5:06:49 PM	92	Standard
Dhoha	7/7/2013 6:23:44 PM	7/7/2013 6:41:06 PM	7/7/2013 6:41:06 PM	7/7/2013 6:56:17 PM	78	Standard
no one	8/15/2013 7:20:44 PM	8/15/2013 7:24:05 PM	8/15/2013 7:24:05 PM	8/15/2013 7:36:38 PM	88	Custom
Hanaa_2	8/16/2013 6:57:13 PM	8/16/2013 7:18:23 PM	8/16/2013 7:18:23 PM	8/16/2013 7:35:12 PM	92	Standard
Eman_5	8/17/2013 4:28:16 AM	8/17/2013 5:25:30 AM	8/17/2013 5:25:30 AM	8/17/2013 5:44:47 AM	100	Standard
Fatimah_0	8/17/2013 4:00:48 PM	8/17/2013 4:12:20 PM	8/17/2013 4:12:21 PM	8/17/2013 4:34:34 PM	95	Standard
Huda_1	8/17/2013 9:09:20 PM	8/17/2013 9:22:41 PM	8/17/2013 9:22:41 PM	8/17/2013 9:31:52 PM	28	Standard
Nouf	8/21/2013 12:22:30 AM	8/21/2013 12:51:57 AM	8/21/2013 12:24:17 AM	8/21/2013 12:50:00 AM	65	Standard
Yusuf_0	8/21/2013 12:29:49 AM	8/21/2013 12:37:03 AM	8/21/2013 12:37:03 AM	8/21/2013 12:44:38 AM	88	Standard
YTYTY	8/28/2013 7:18:40 PM	8/28/2013 7:20:23 PM	8/28/2013 7:20:23 PM	8/28/2013 7:25:25 PM	25	Standard
Asem Hassan_2	8/28/2013 9:51:38 PM	8/28/2013 9:53:56 PM	8/28/2013 9:53:57 PM	8/28/2013 10:13:19 PM	95	Custom
Saja Khaled	8/28/2013 10:25:54 PM	8/28/2013 10:35:16 PM	8/28/2013 10:26:33 PM	8/28/2013 10:33:43 PM	100	Custom
Saja Khaled_0	8/28/2013 10:36:02 PM	8/28/2013 10:36:23 PM	8/28/2013 10:36:23 PM	8/28/2013 10:43:27 PM	95	Custom
Tahani Al hamod_0	9/1/2013 6:04:02 PM	9/1/2013 6:34:20 PM	9/1/2013 6:34:20 PM	9/1/2013 7:11:01 PM	80	Standard
Volnteer	9/17/2013 11:22:11 PM	9/17/2013 11:24:43 PM	9/17/2013 11:24:44 PM	9/17/2013 11:31:13 PM	52	Standard
Dhafir	9/19/2013 8:41:18 PM	9/19/2013 8:55:12 PM	9/19/2013 8:55:12 PM	9/19/2013 9:16:23 PM	85	Standard
Njoud	9/25/2013 8:25:48 PM	9/25/2013 8:27:44 PM	9/25/2013 8:27:44 PM	9/25/2013 8:51:28 PM	62	Standard
Khalid Abdullah	9/26/2013 11:38:20 PM	9/26/2013 11:45:12 PM	9/26/2013 11:45:12 PM	9/26/2013 11:55:19 PM	60	Custom
aseel	9/27/2013 12:09:36 AM	9/27/2013 12:12:47 AM	9/27/2013 12:12:47 AM	9/27/2013 12:14:52 AM	18	Custom
Natalie	9/27/2013 2:11:17 AM	9/27/2013 2:15:54 AM	9/27/2013 2:15:54 AM	9/27/2013 2:23:37 AM	92	Custom
testadap	9/29/2013 6:18:37 AM	9/29/2013 6:19:24 AM	9/29/2013 6:19:30 AM	9/29/2013 6:20:45 AM	30	Adaptive
test1_0	10/1/2013 7:39:23 AM	10/1/2013 7:40:36 AM	10/1/2013 7:40:36 AM	10/1/2013 7:42:46 AM	22	Adaptive
m1	10/9/2013 9:57:02 PM	10/9/2013 10:00:45 PM	10/9/2013 10:00:45 PM	10/9/2013 10:02:58 PM	32	Adaptive
Lila	10/9/2013 10:52:34 PM	10/9/2013 10:58:47 PM	10/9/2013 10:58:47 PM	10/9/2013 11:11:50 PM	100	Standard
Noufa mouhammed	10/9/2013 11:38:15 PM	10/9/2013 11:45:25 PM	10/9/2013 11:45:25 PM	10/9/2013 11:54:47 PM	68	Standard
Gadder	10/9/2013 11:59:40 PM	10/10/2013 12:01:58 AM	10/10/2013 12:01:58 AM	10/10/2013 12:08:41 AM	65	Standard
Uhood	10/10/2013 12:11:43 AM	10/10/2013 12:12:36 AM	10/10/2013 12:12:36 AM	10/10/2013 12:15:58 AM	40	Standard
Nuria	10/10/2013 5:20:31 PM	10/10/2013 5:34:06 PM	10/10/2013 5:34:06 PM	10/10/2013 5:44:22 PM	82	Standard
Lila_2	10/10/2013 6:01:53 PM	10/10/2013 6:03:36 PM	10/10/2013 6:03:36 PM	10/10/2013 6:12:40 PM	75	Standard
Huda_2	10/11/2013 12:47:45 PM	10/11/2013 1:00:24 PM	10/11/2013 1:00:25 PM	10/11/2013 1:13:58 PM	52	Standard

Figure 32: Data statistics combine view for all three systems

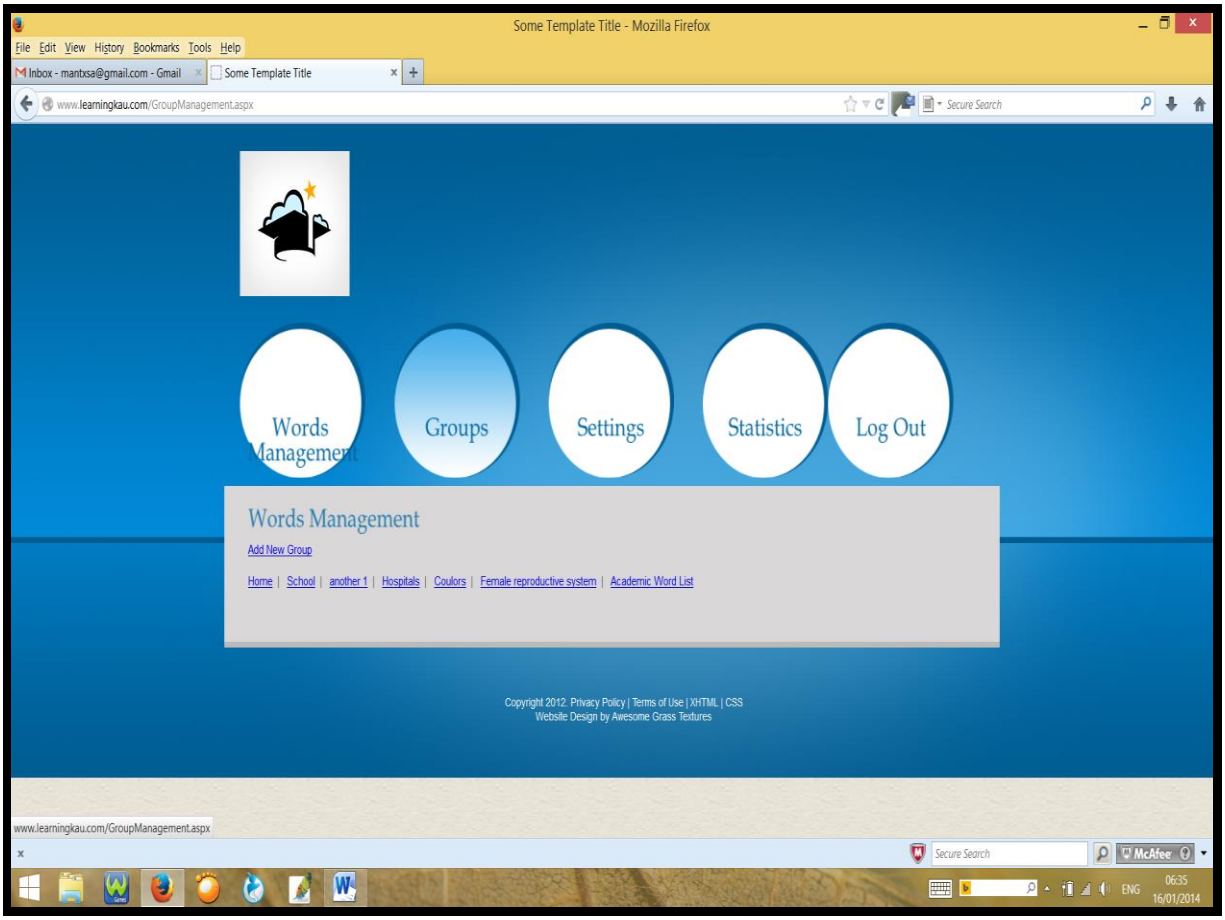


Figure 33: Group learning words management

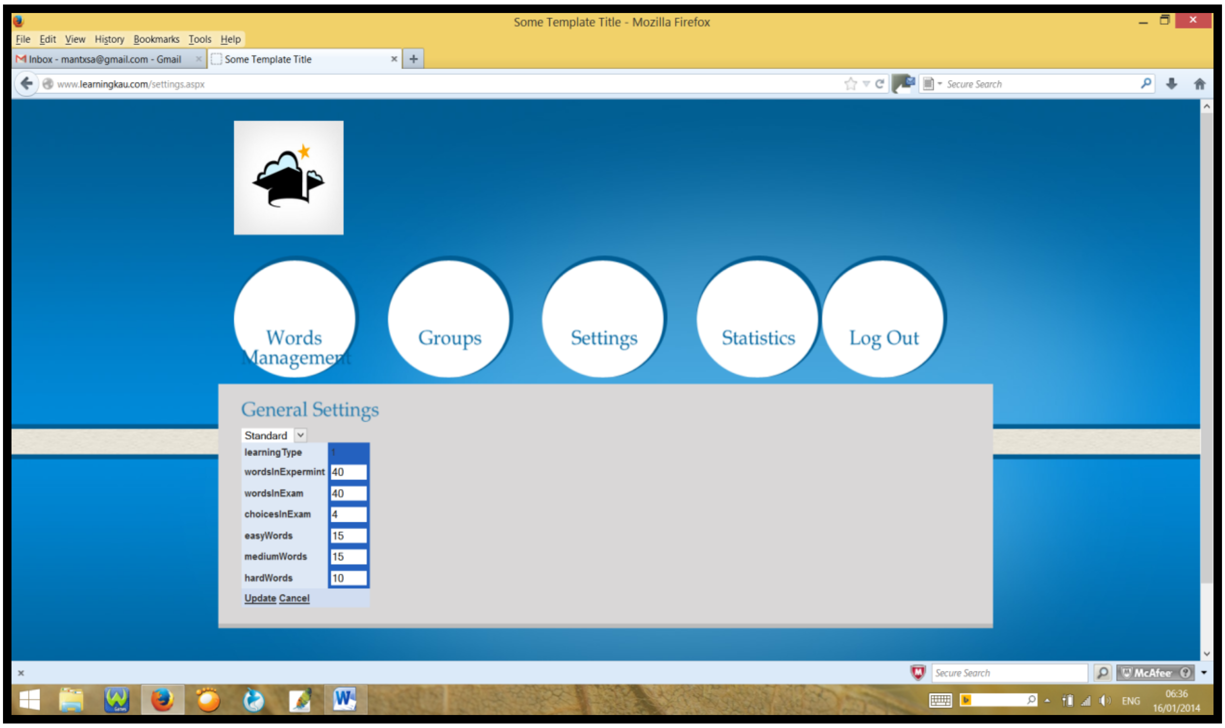


Figure 34: Word setting control

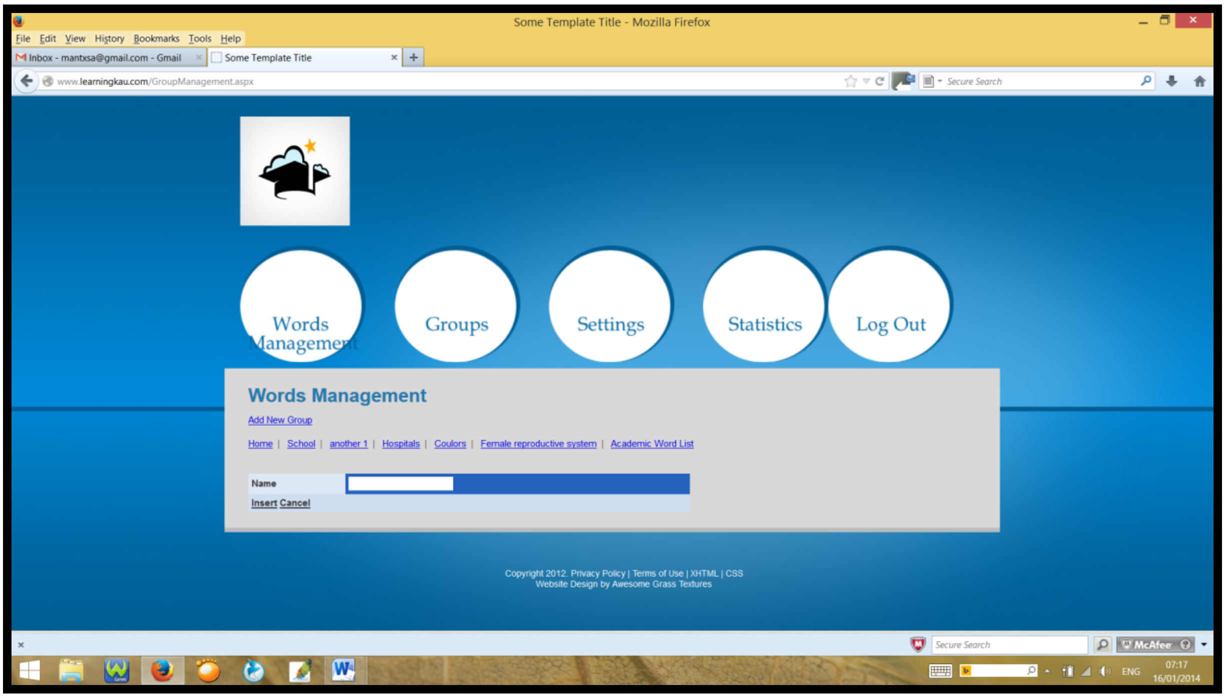


Figure 35: Group combine add list

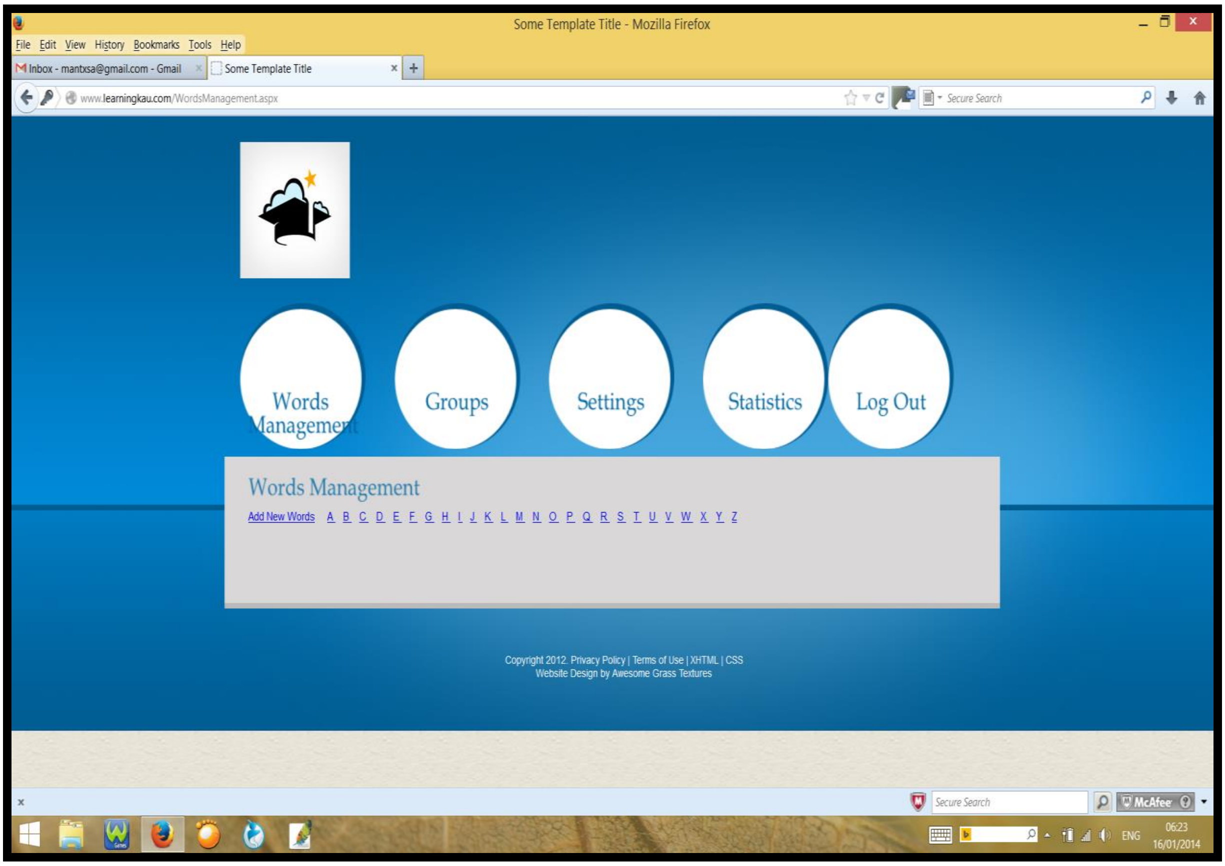


Figure 36: Home page for the system

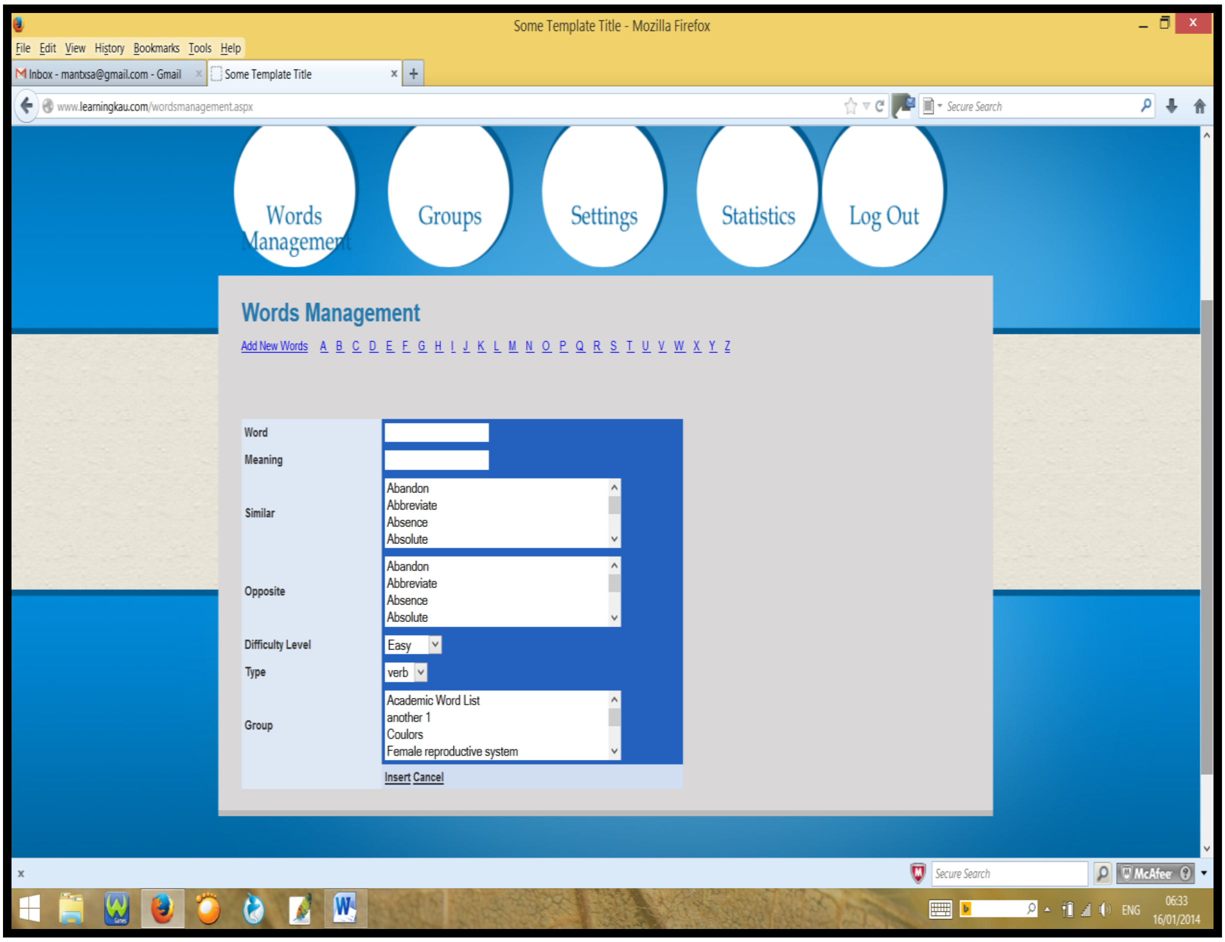


Figure 37: Word management control system

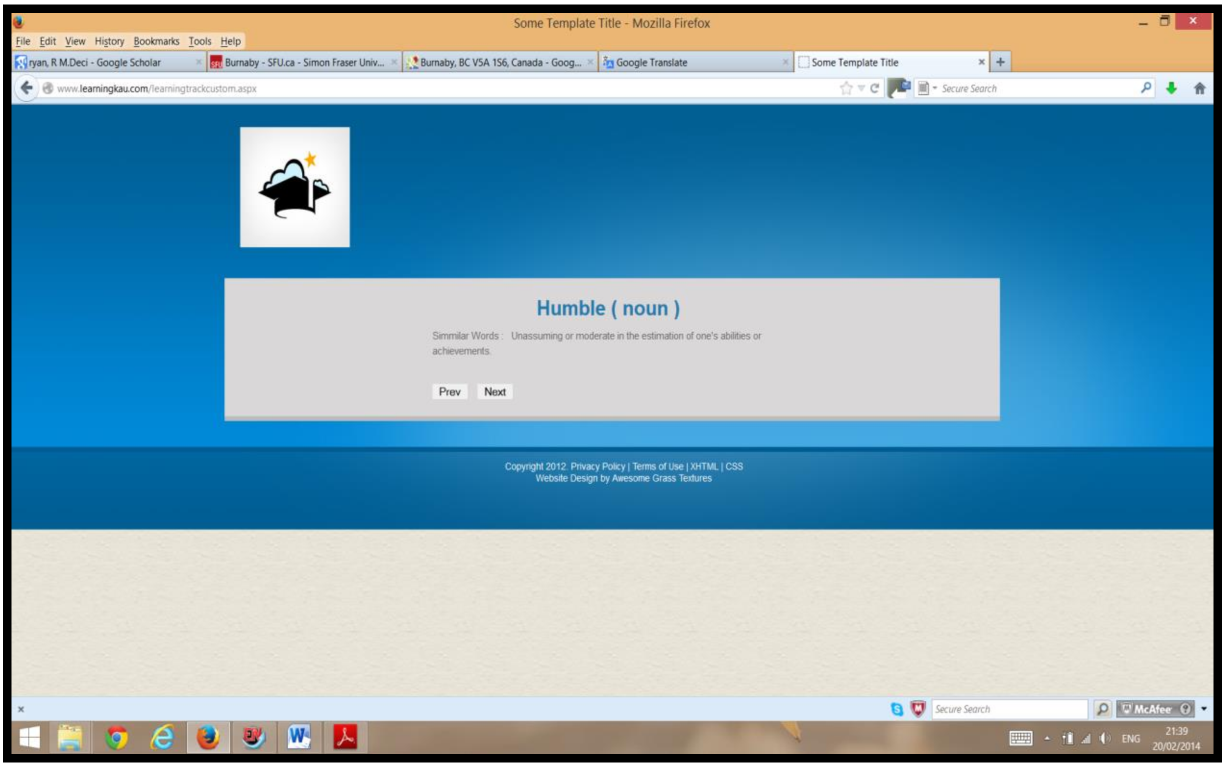


Figure 38: Learning with antonyms word

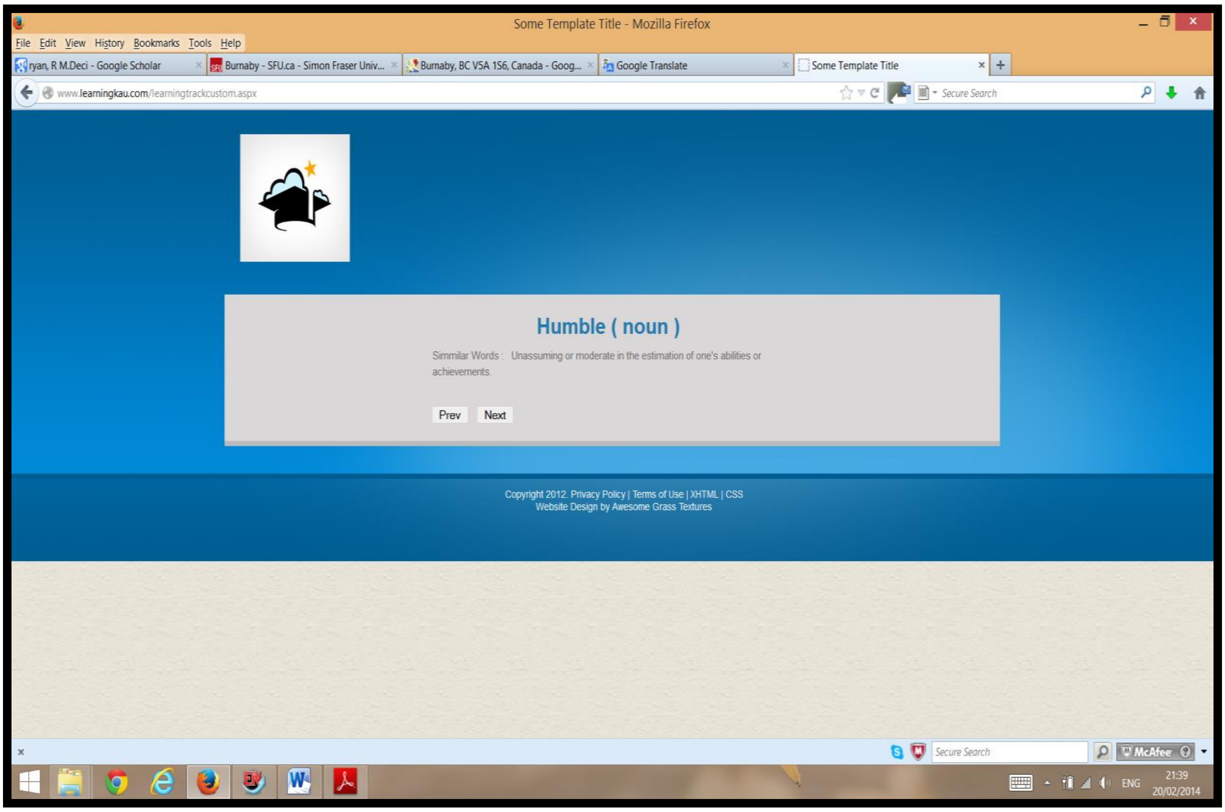


Figure 39: Learning with similar

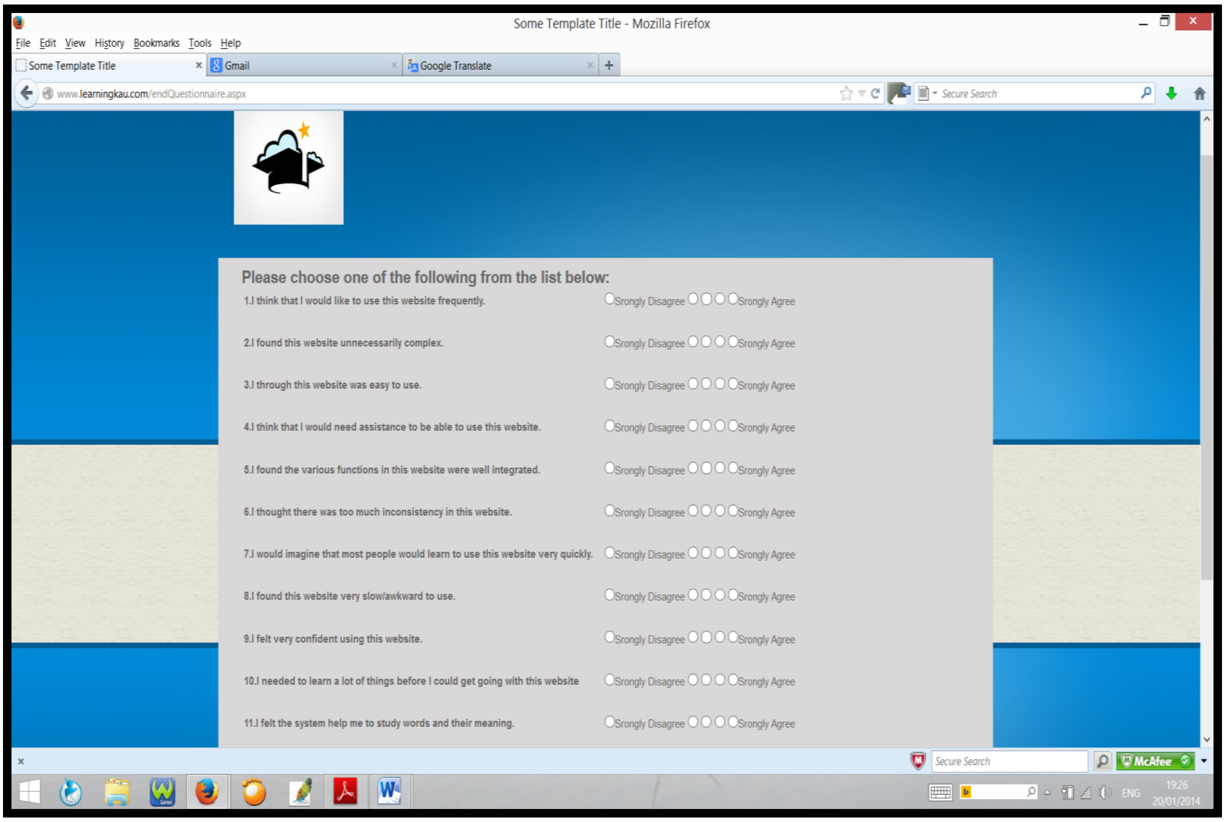


Figure 40: SUS question survey

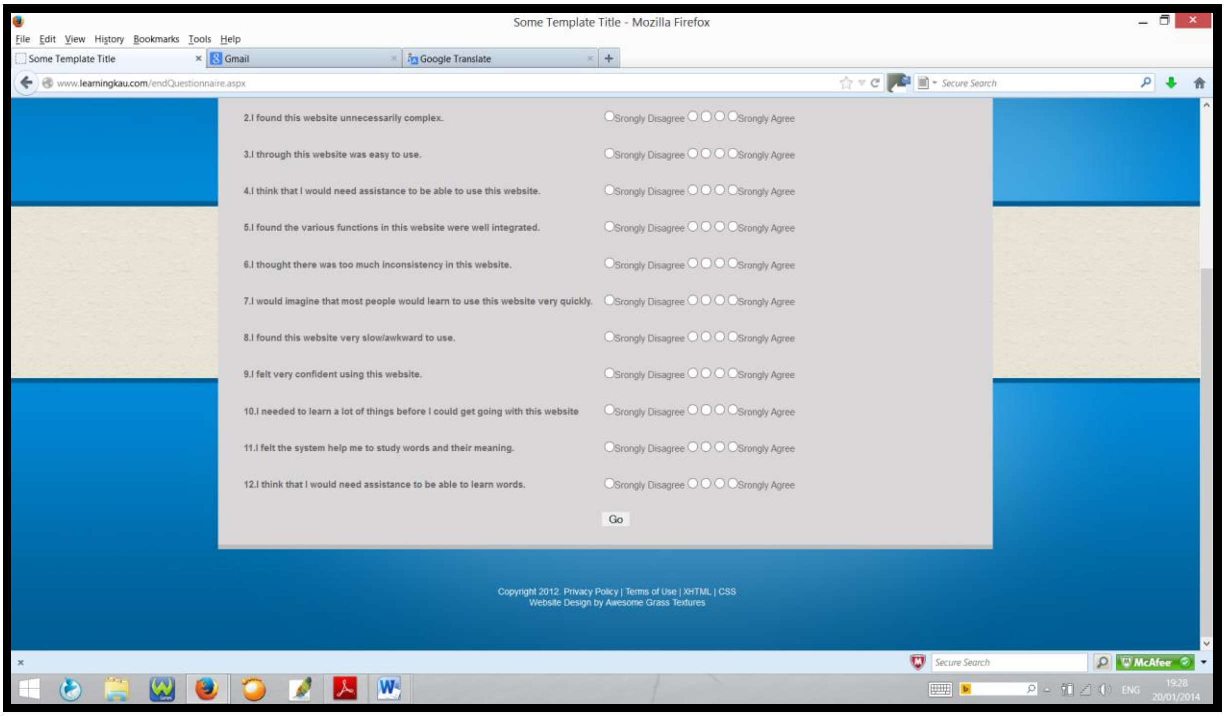


Figure 41: SUS post-question survey continuation

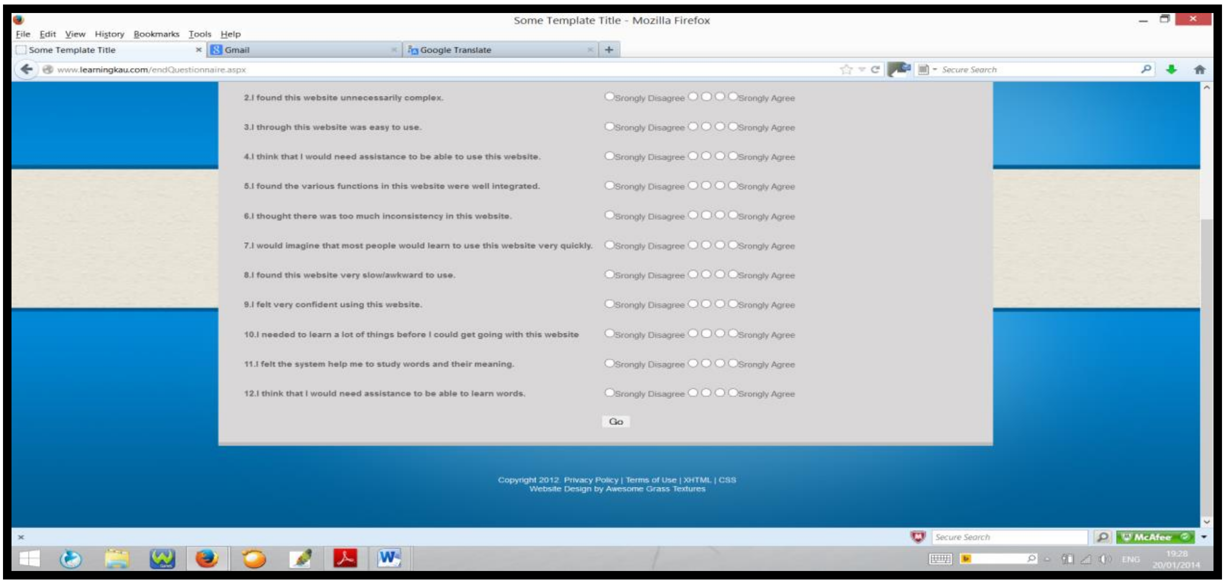


Figure 42: SUS post-question survey continuation

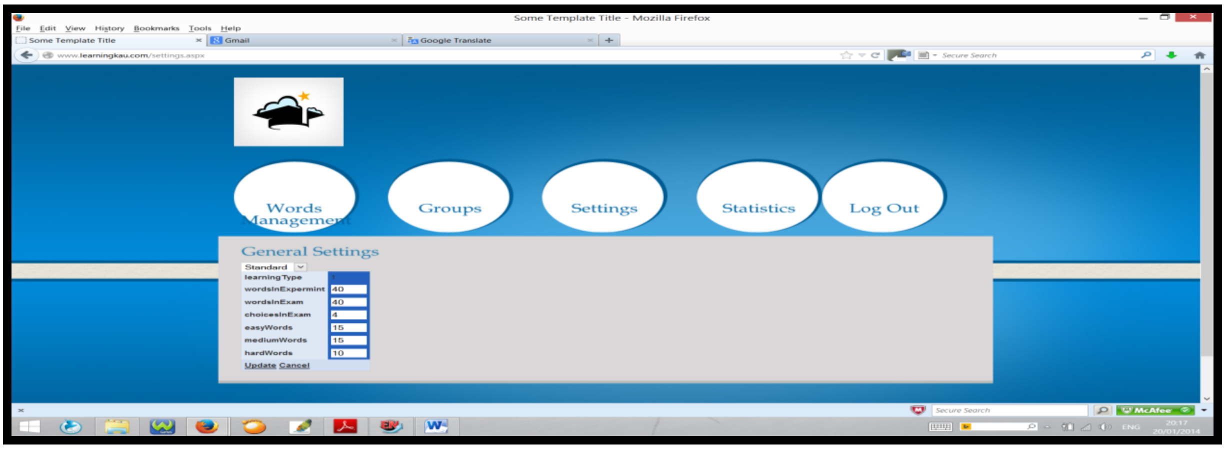


Figure 43: Static word management control

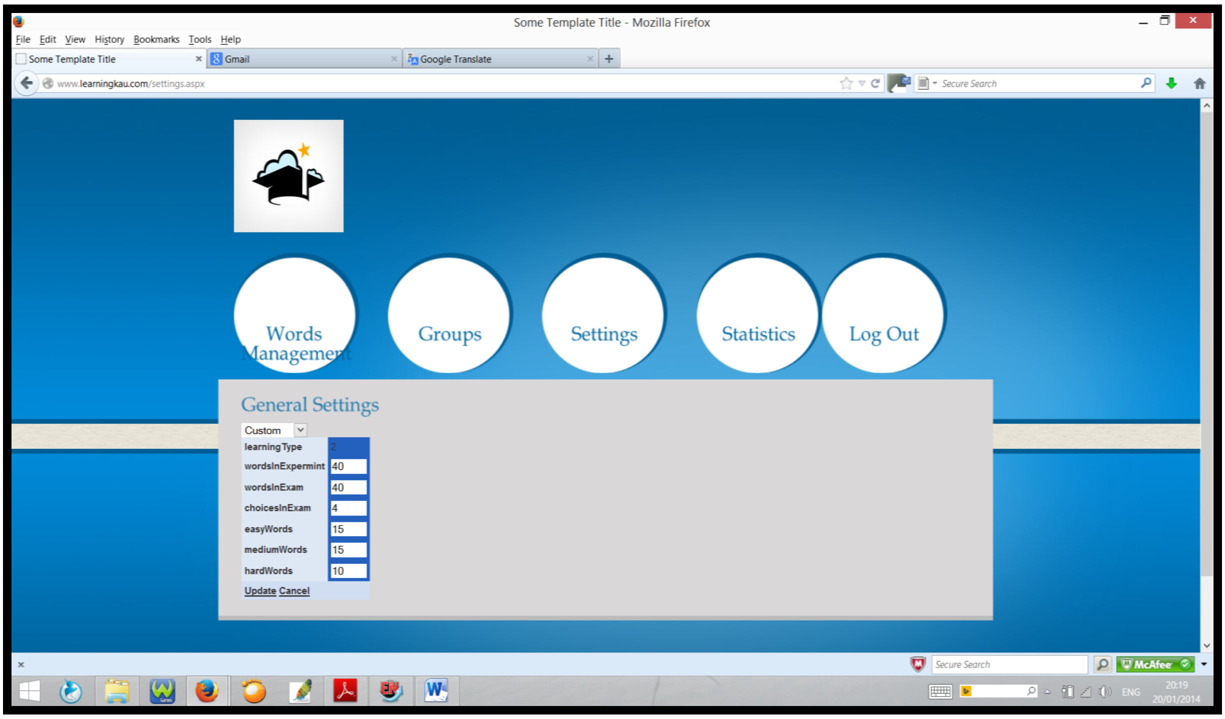


Figure 44: Adaptable word management control

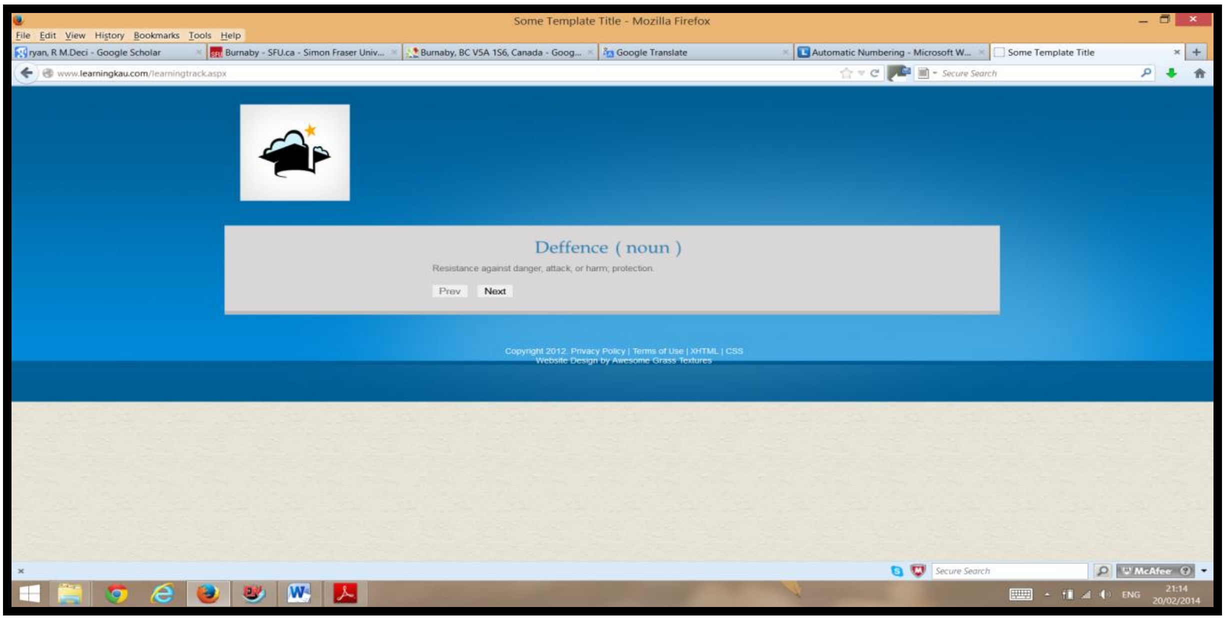


Figure 45: Static system word and its meaning

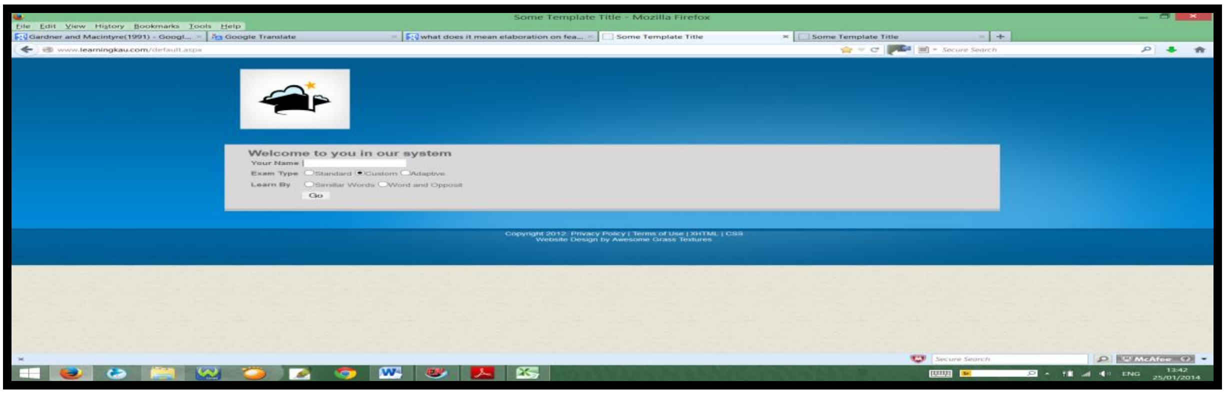


Figure 46: Adaptable system layout login

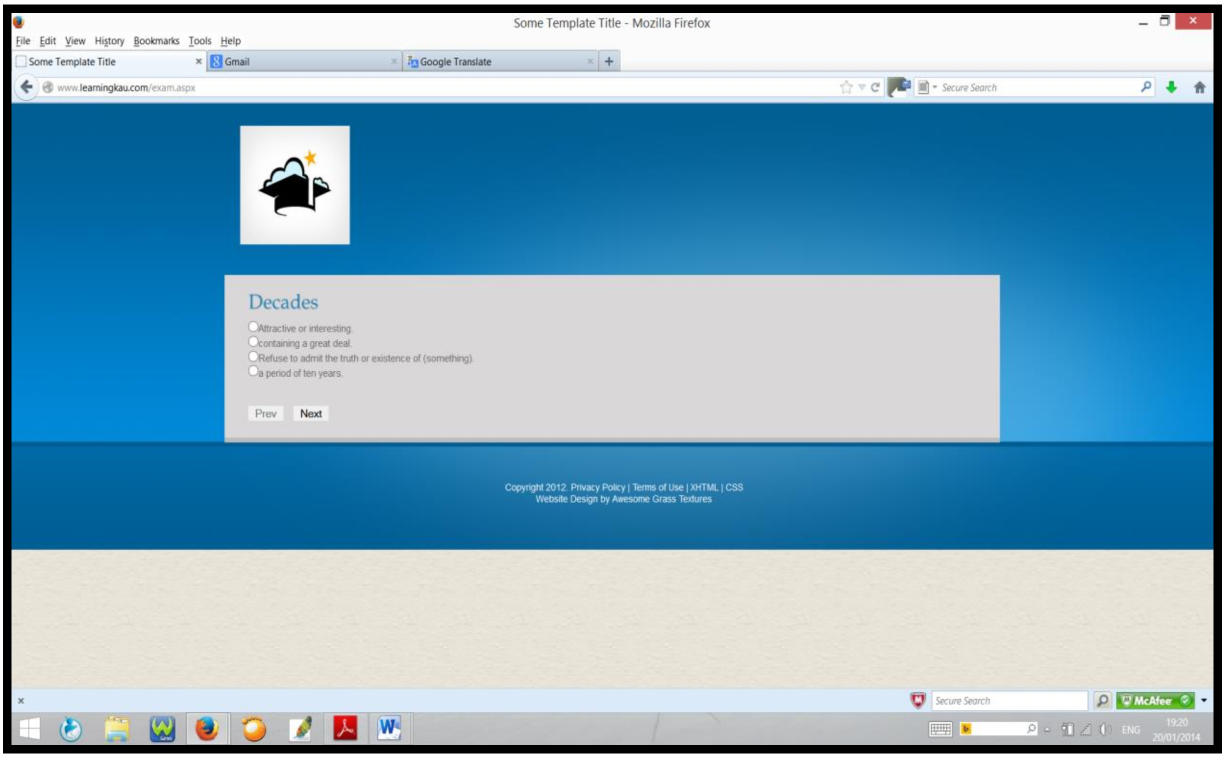


Figure 47: Word testing, multiple-choice

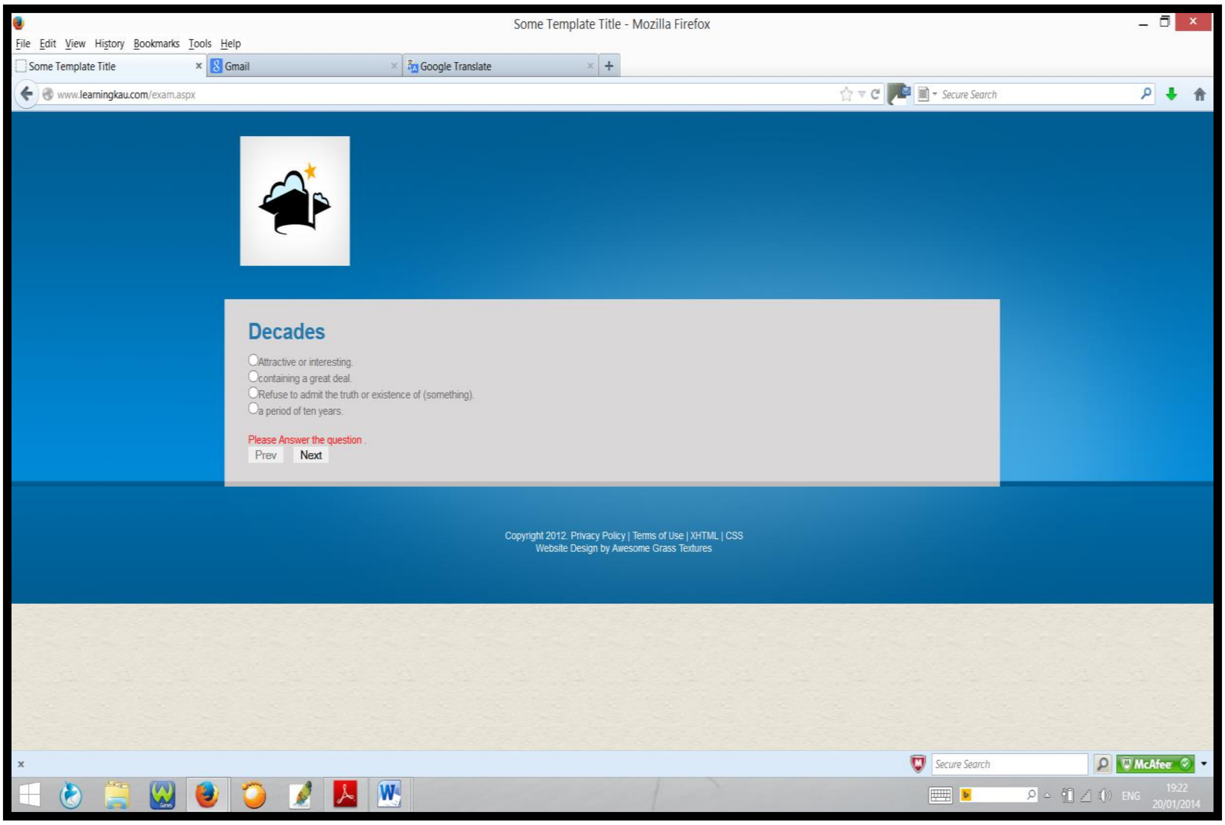


Figure 48: Usability testing for unanswered question

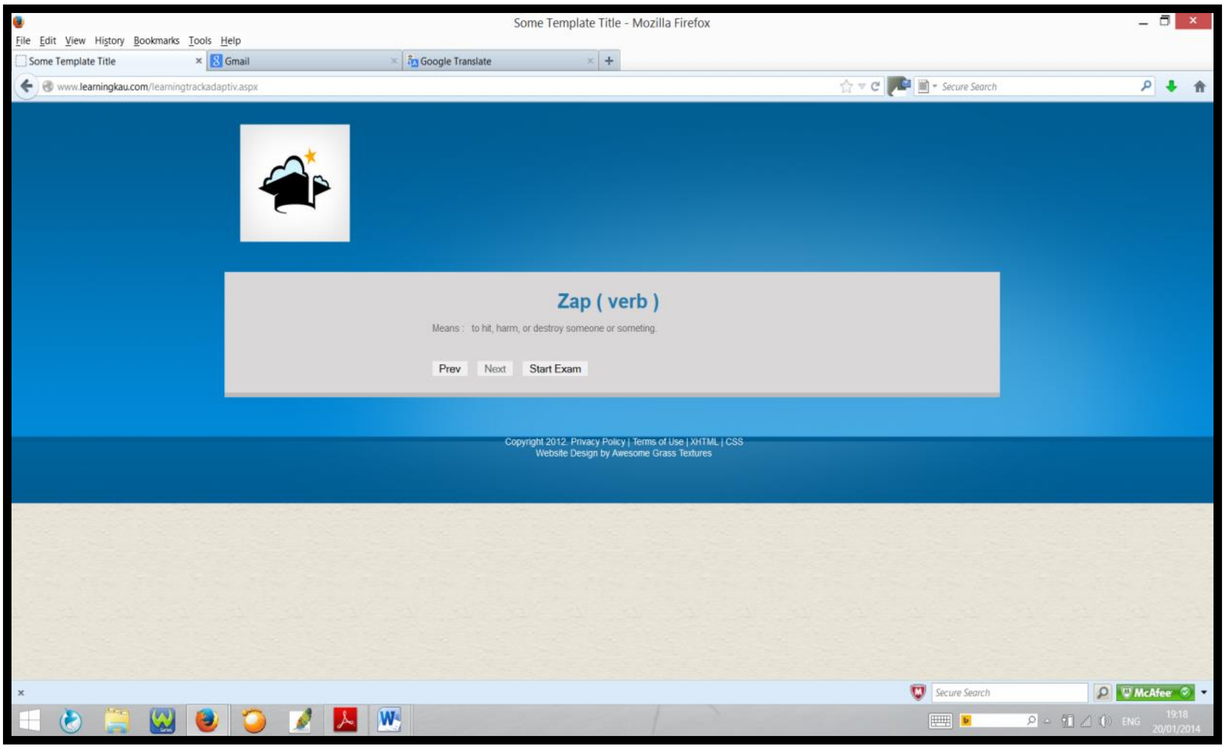


Figure 49: Last page after learning session and ready for exam

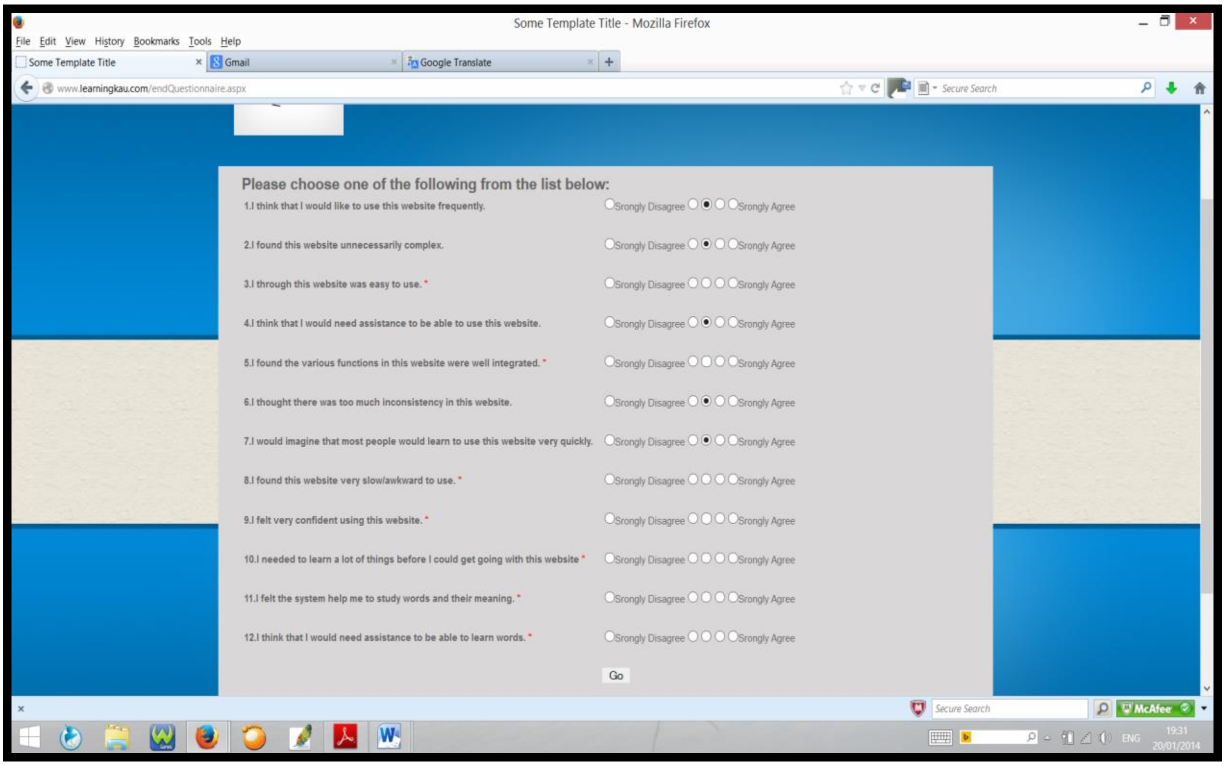


Figure 50: Usability testing for unanswered SUS question

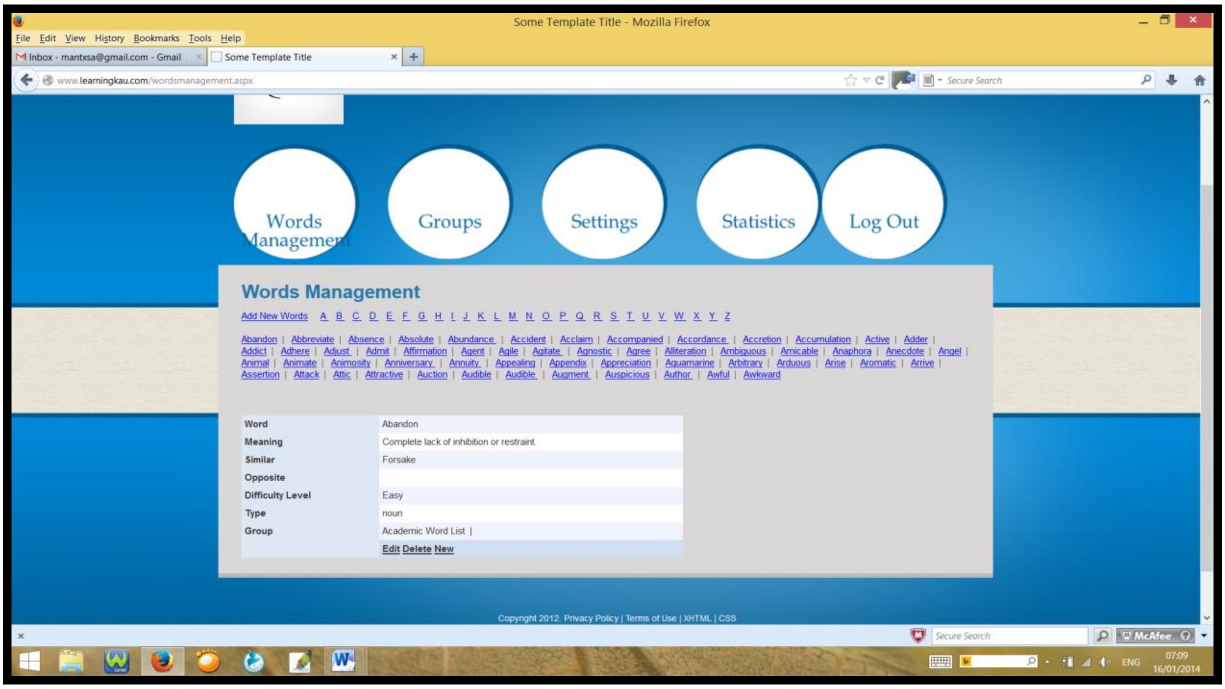


Figure 51: Word description and categorisation display

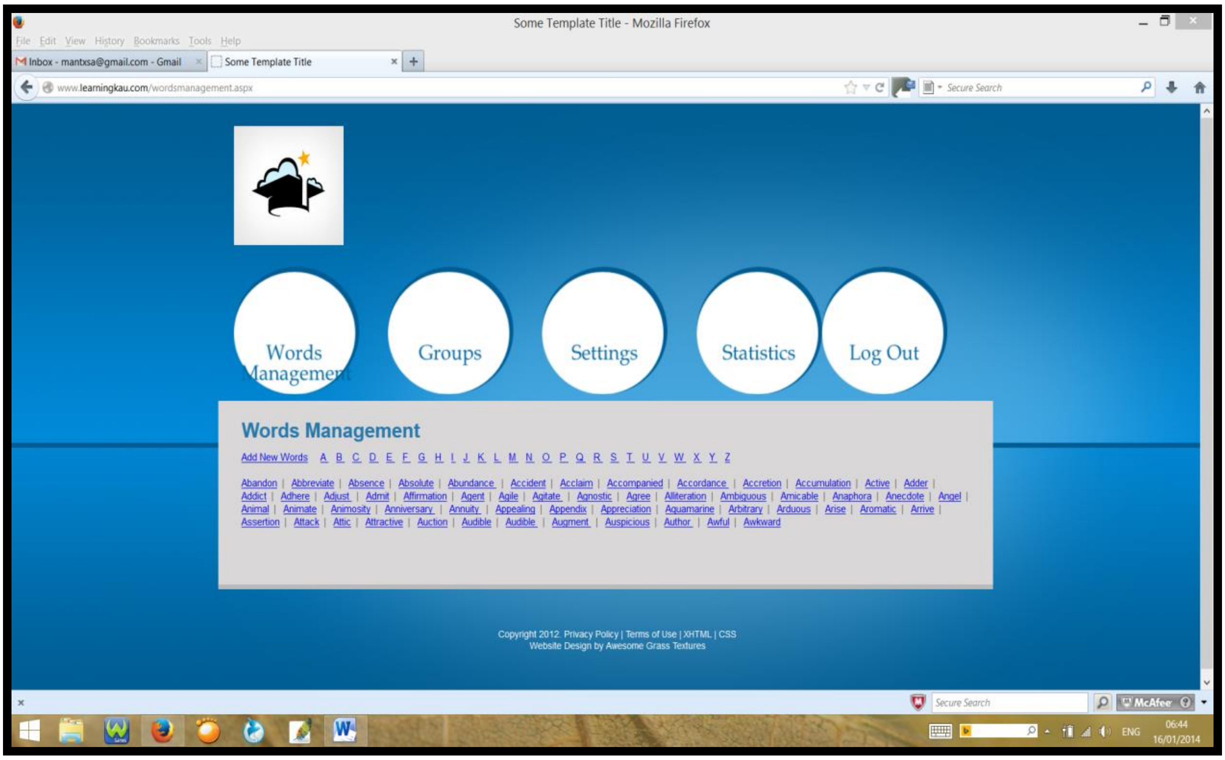


Figure 52: Word management list for words starting with A

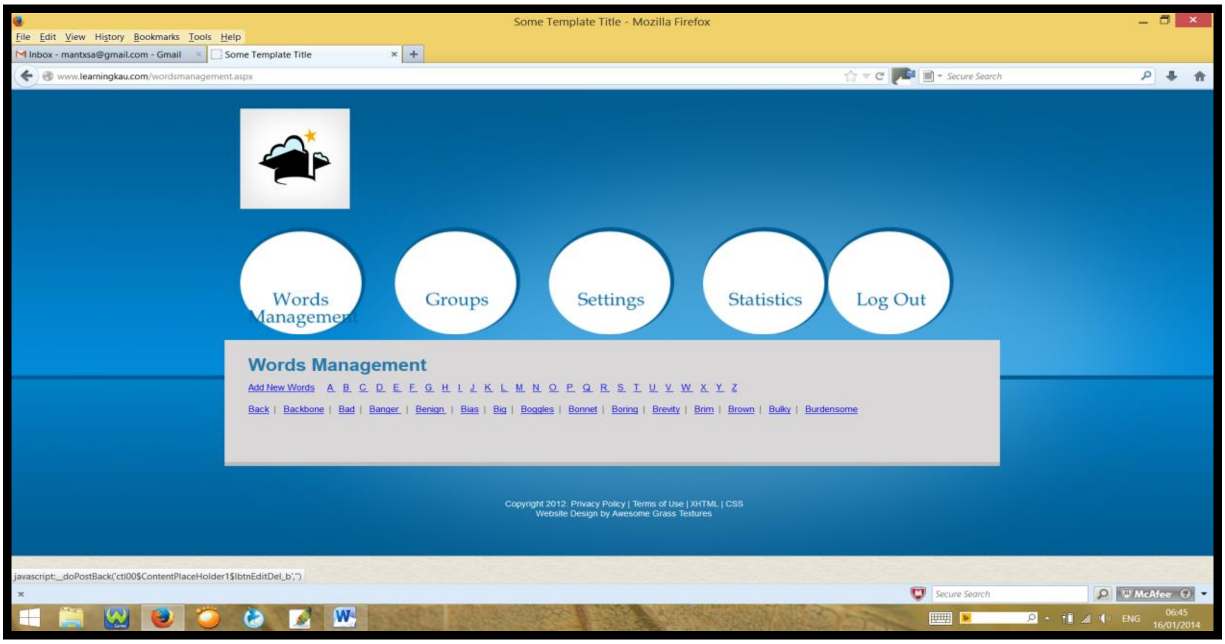


Figure 53: Word management listing with letter B

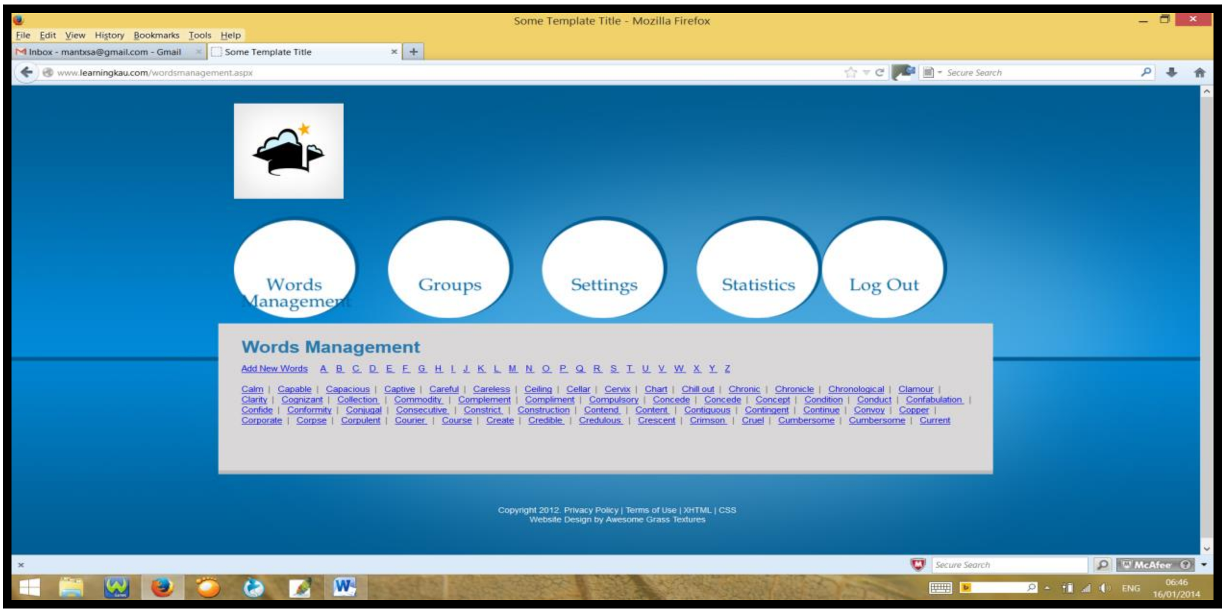


Figure 54: Word management listing with letter C

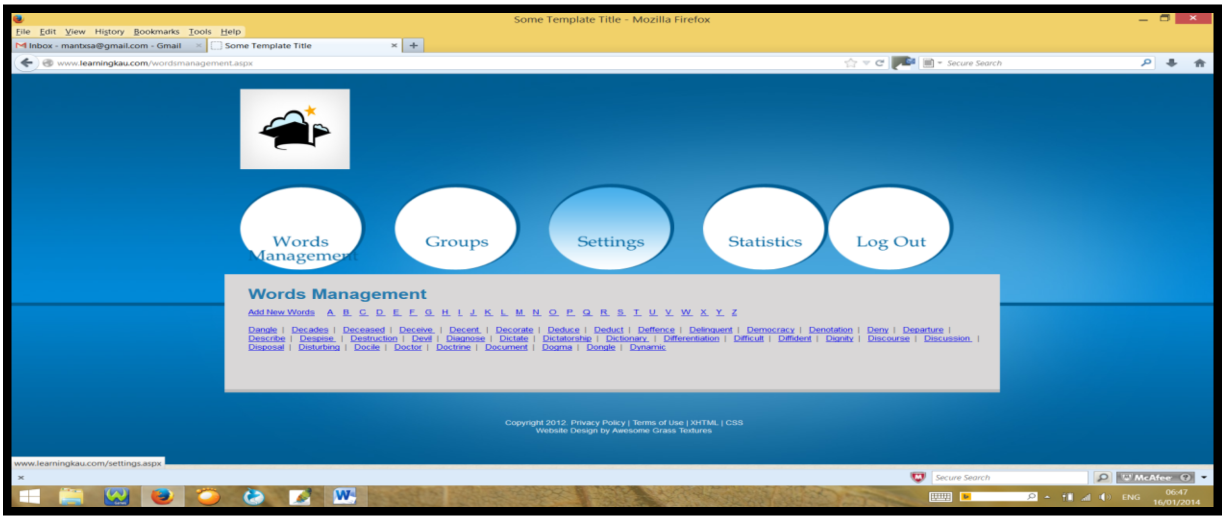


Figure 55: Word management listing with letter D

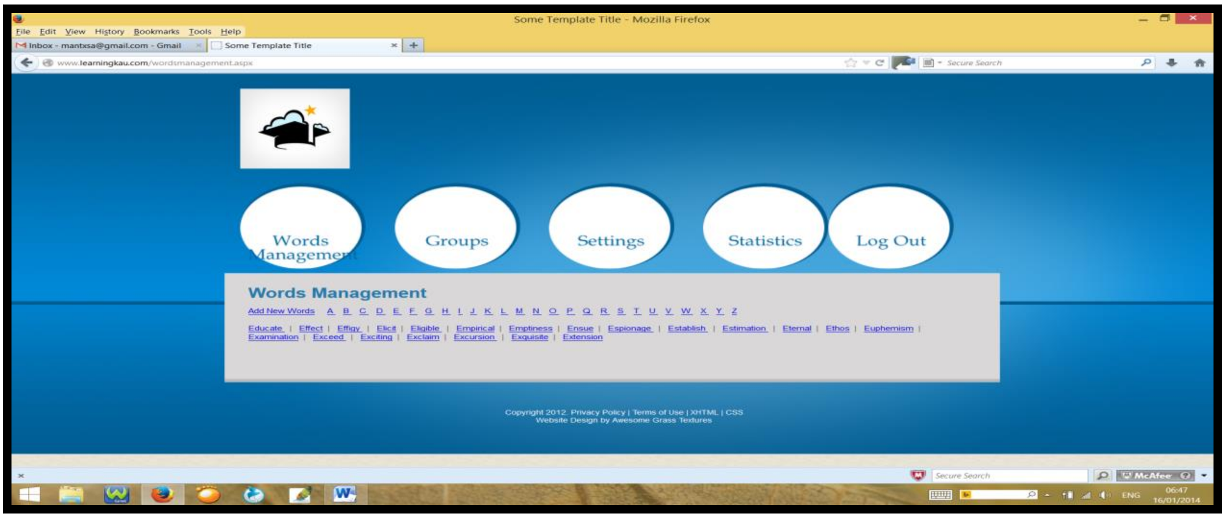


Figure 56: Word management listing with letter E

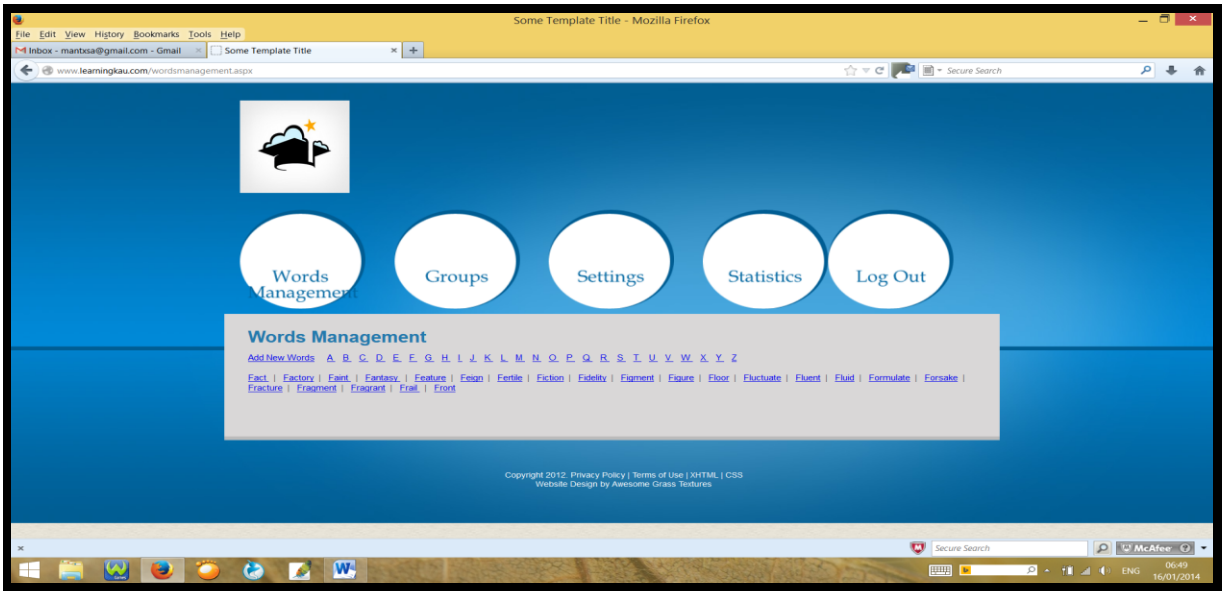


Figure 57: Word management listing with letter F

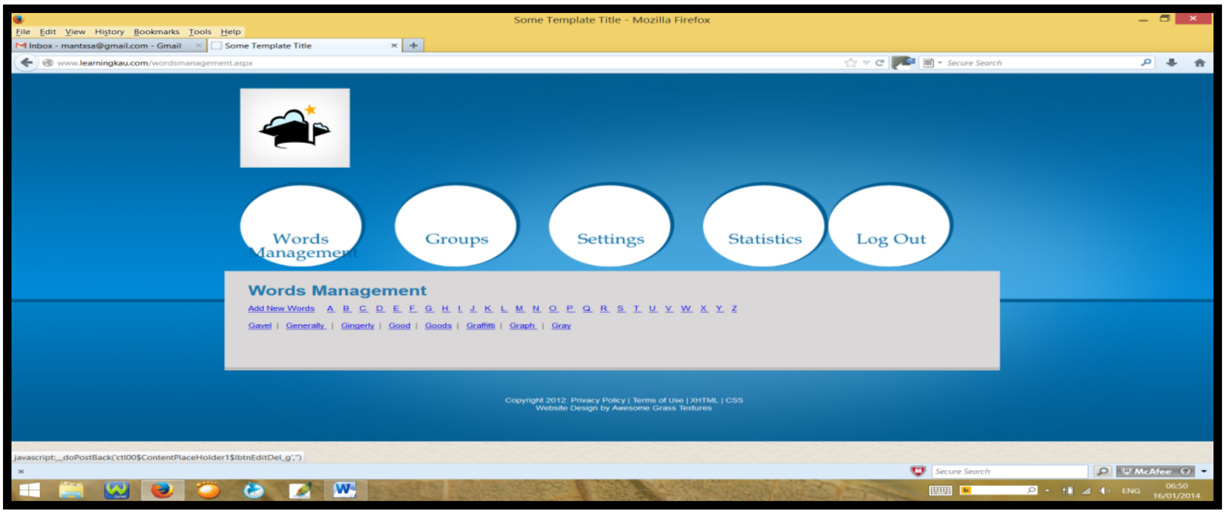


Figure 58: Word management listing with letter G

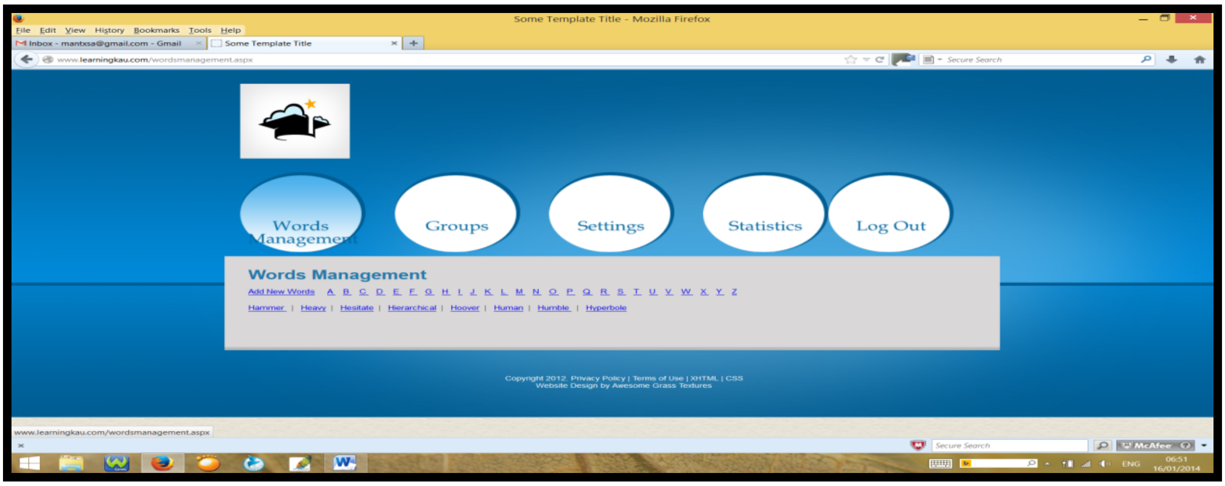


Figure 59: Word management listing with letter H

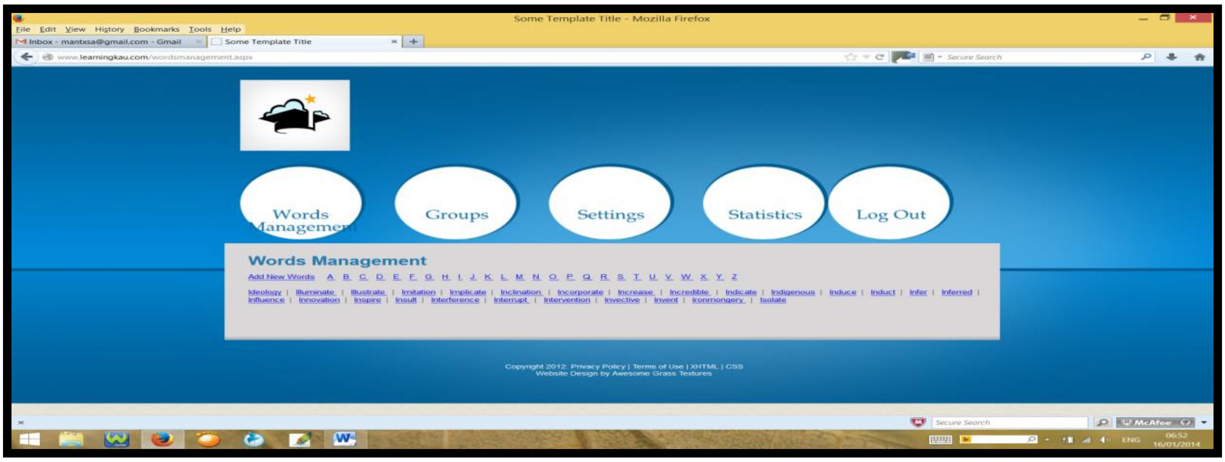


Figure 60: Word management listing with letter I

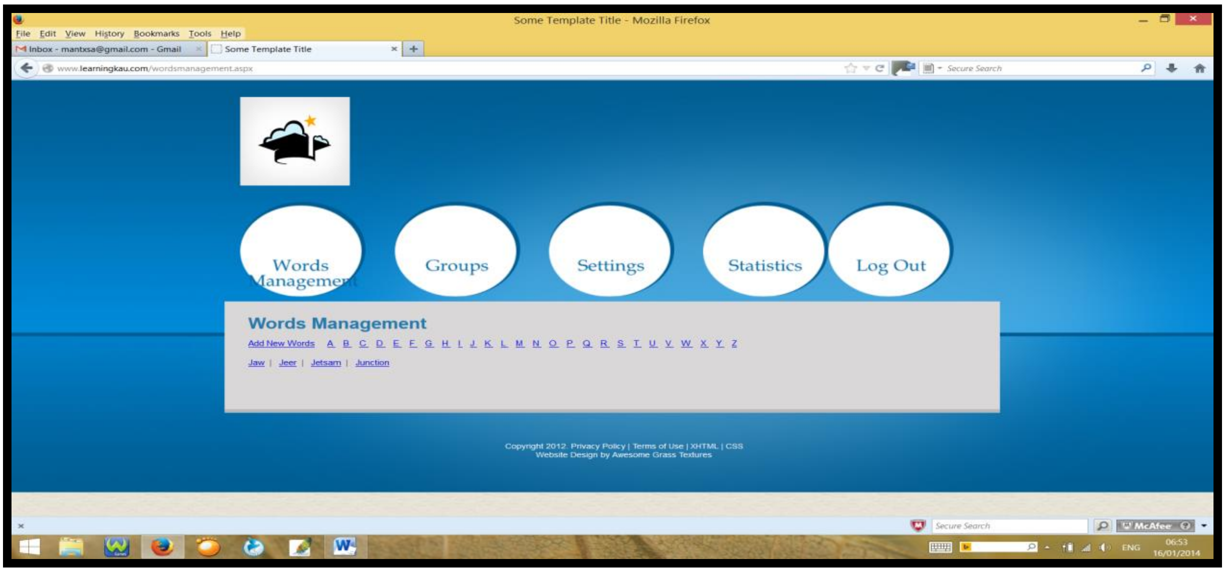


Figure 61: Word management listing with letter J

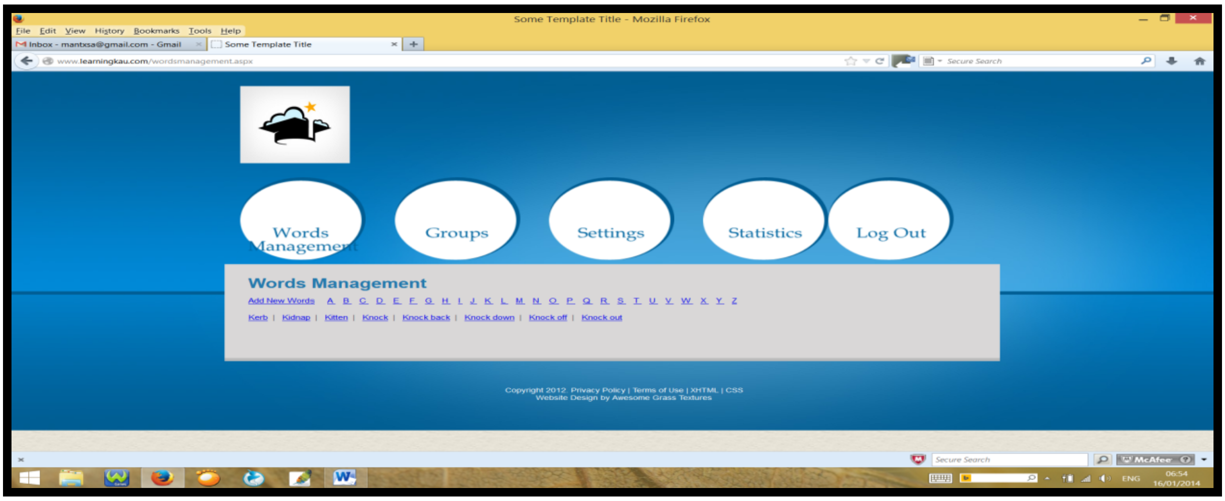


Figure 62: Word management listing with letter K

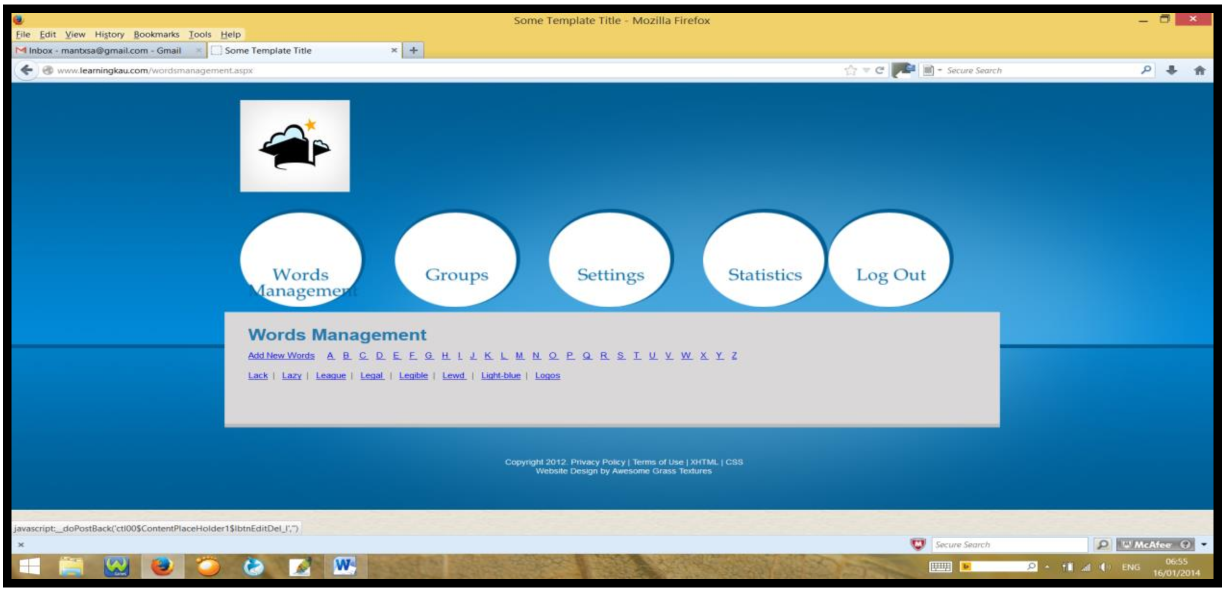


Figure 63: Word management listing with letter L

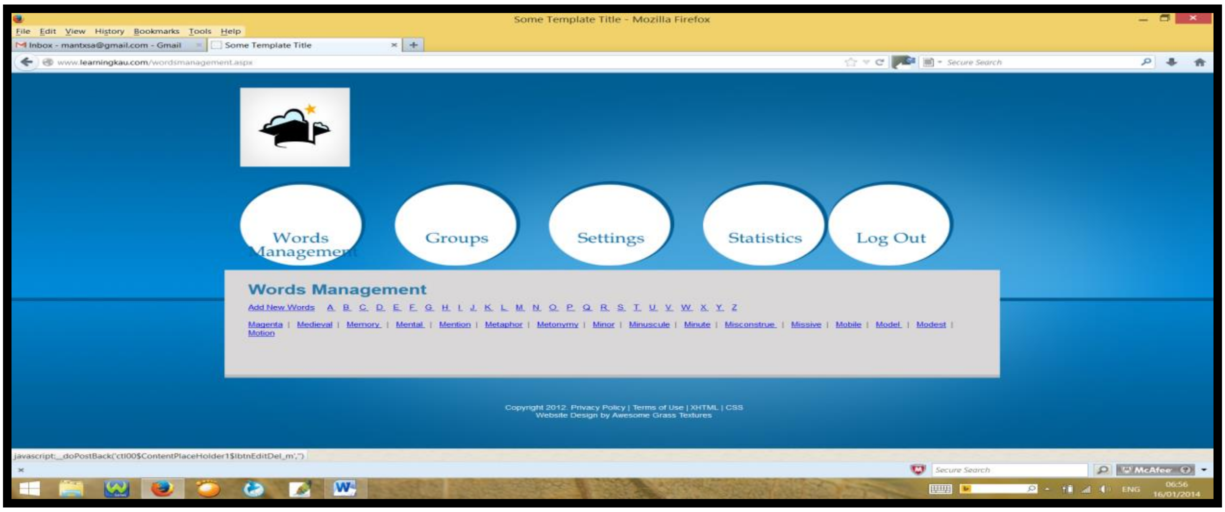


Figure 64: Word management listing with letter M

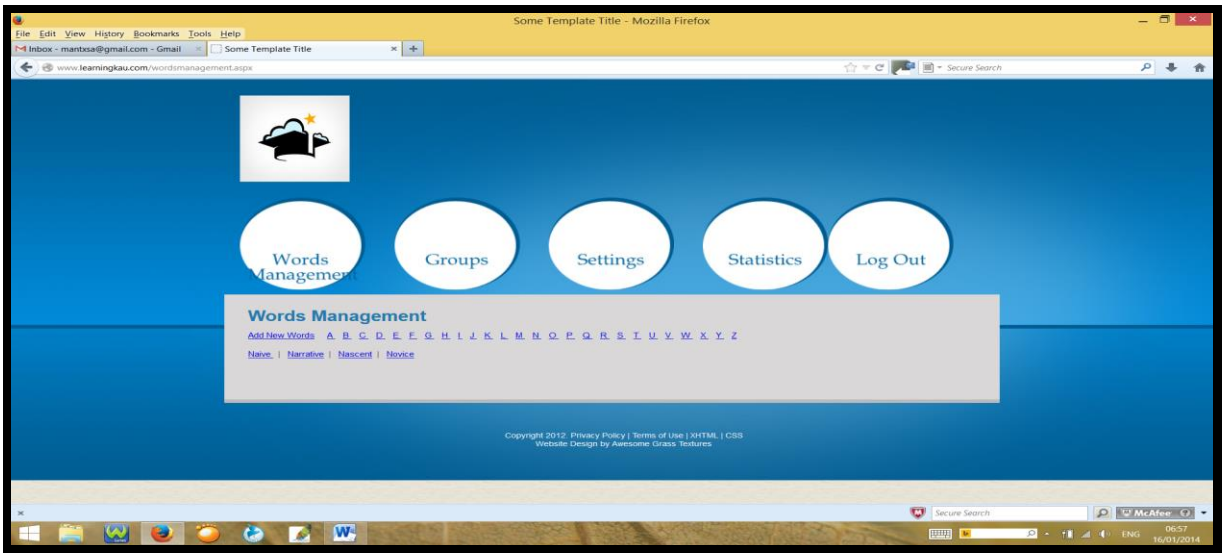


Figure 65: Word management listing with letter N

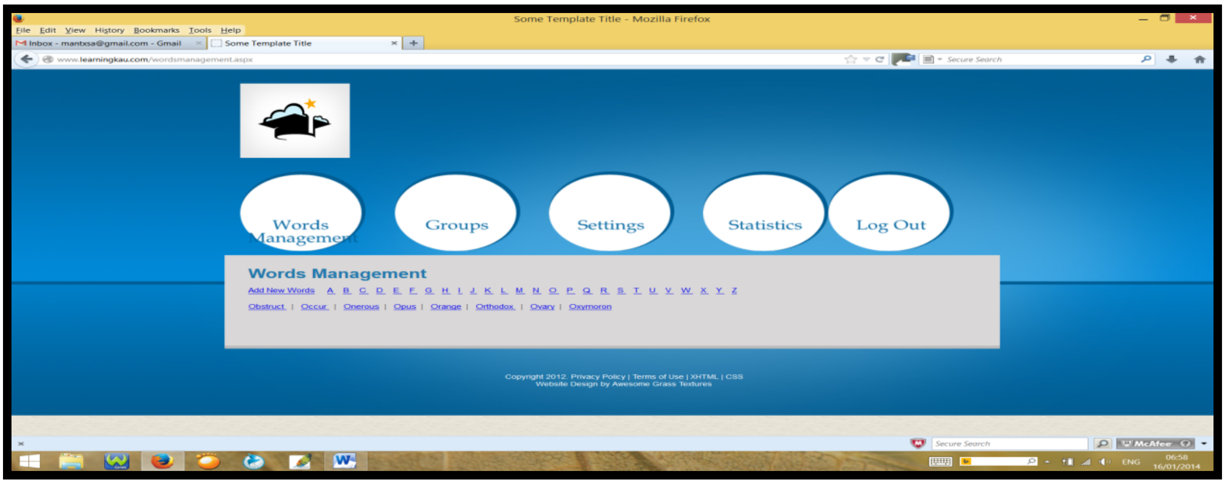


Figure 66: Word management listing with letter O

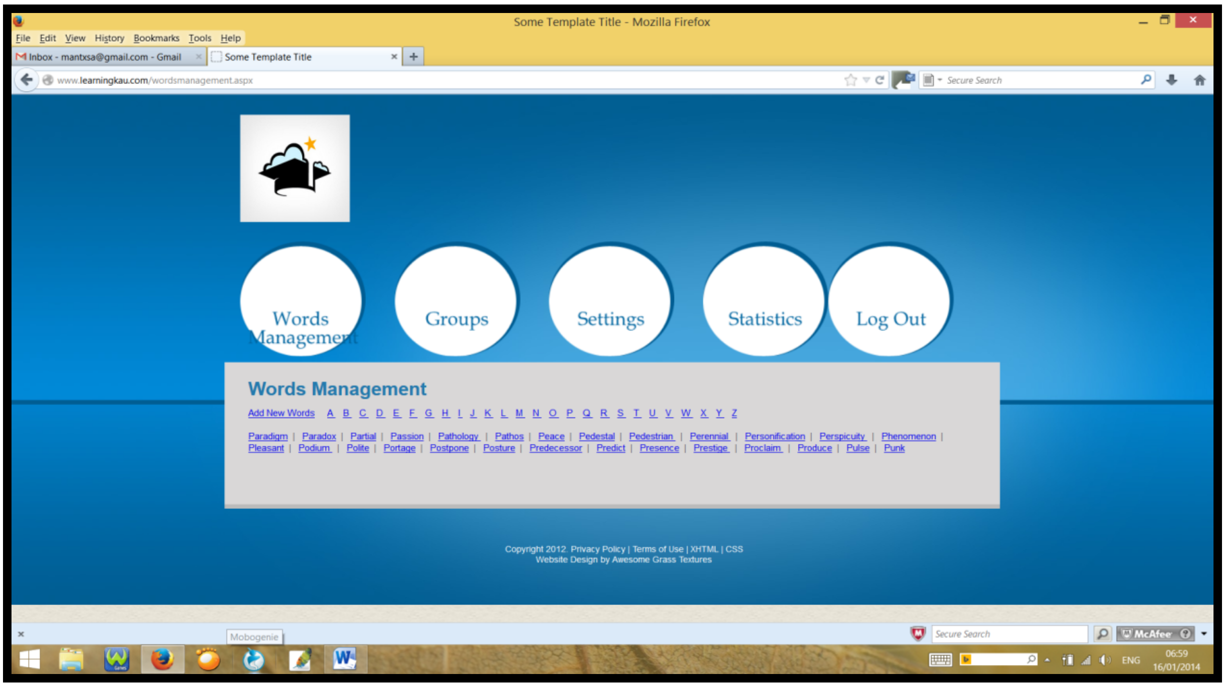


Figure 67: Word management listing with letter P

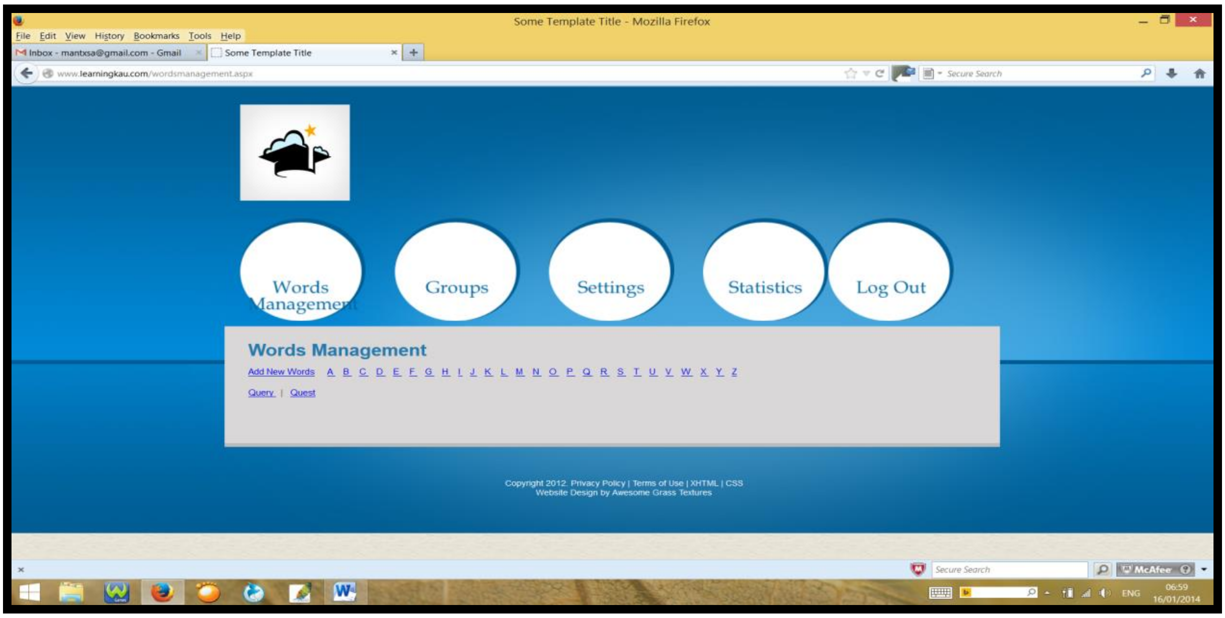


Figure 68: Word management listing with letter Q

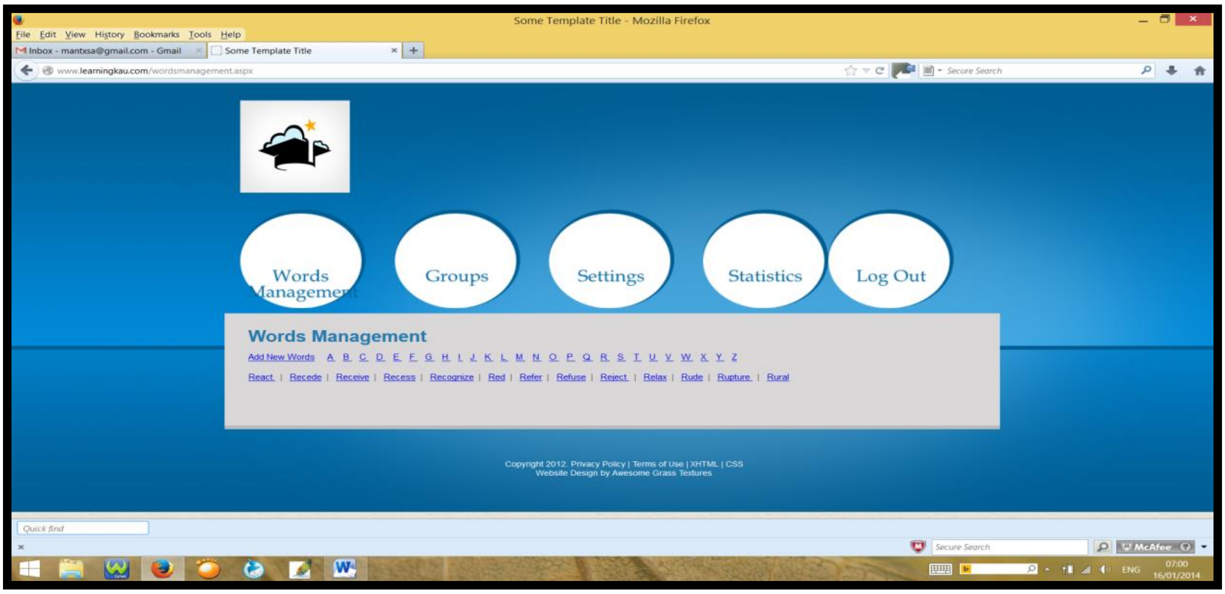


Figure 69: Word management listing with letter R

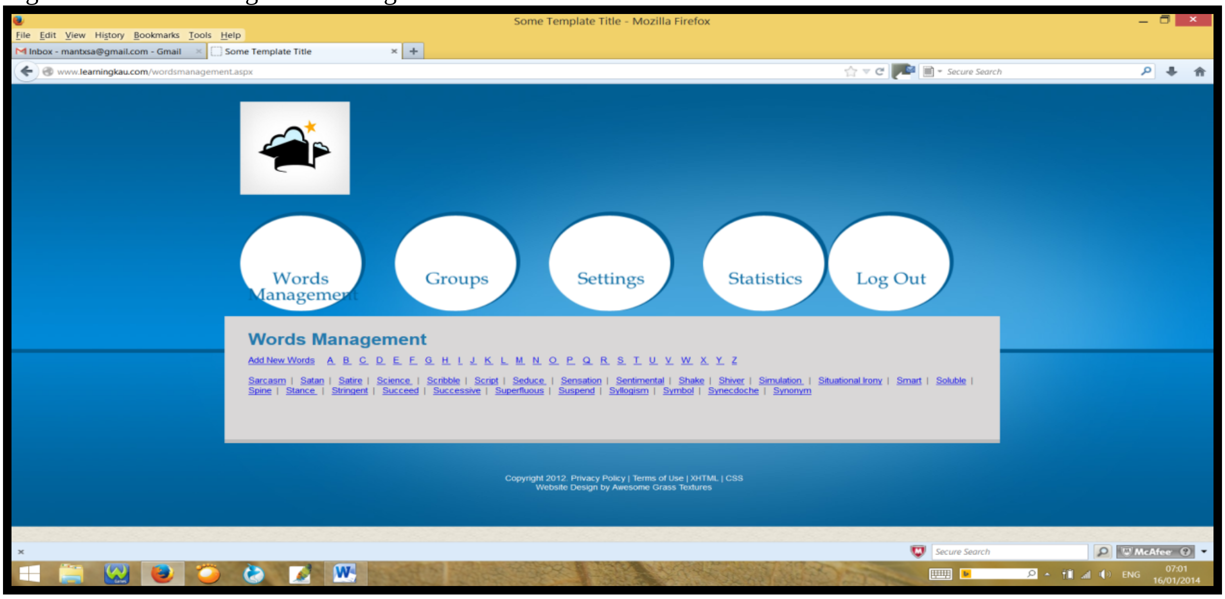


Figure 70: Word management listing with letter S

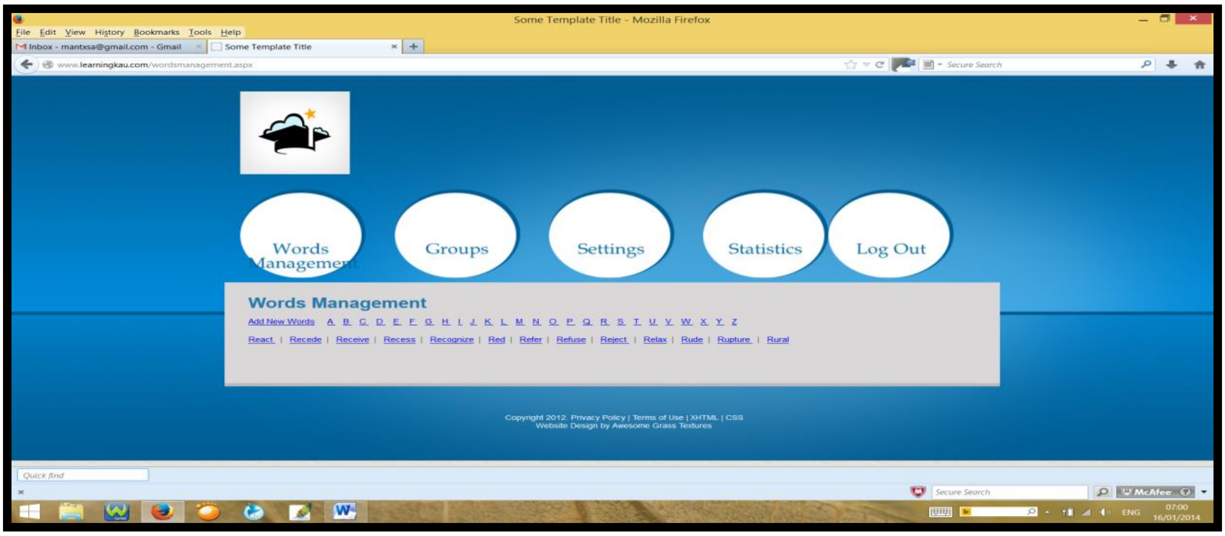


Figure 71: Word management listing with letter T

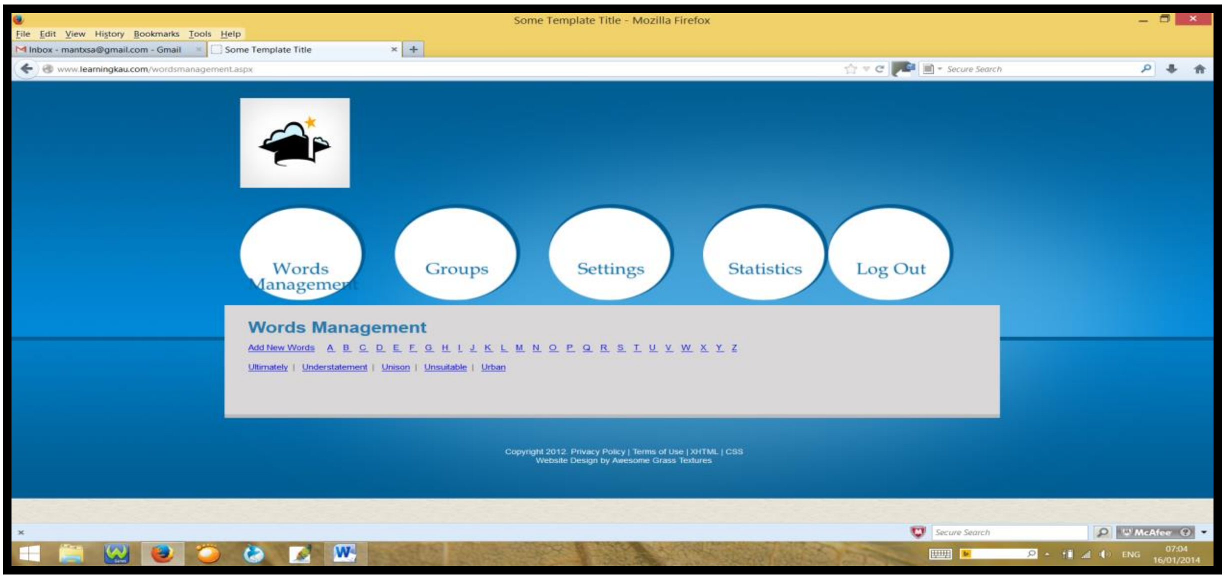


Figure 72: Word management listing with letter U

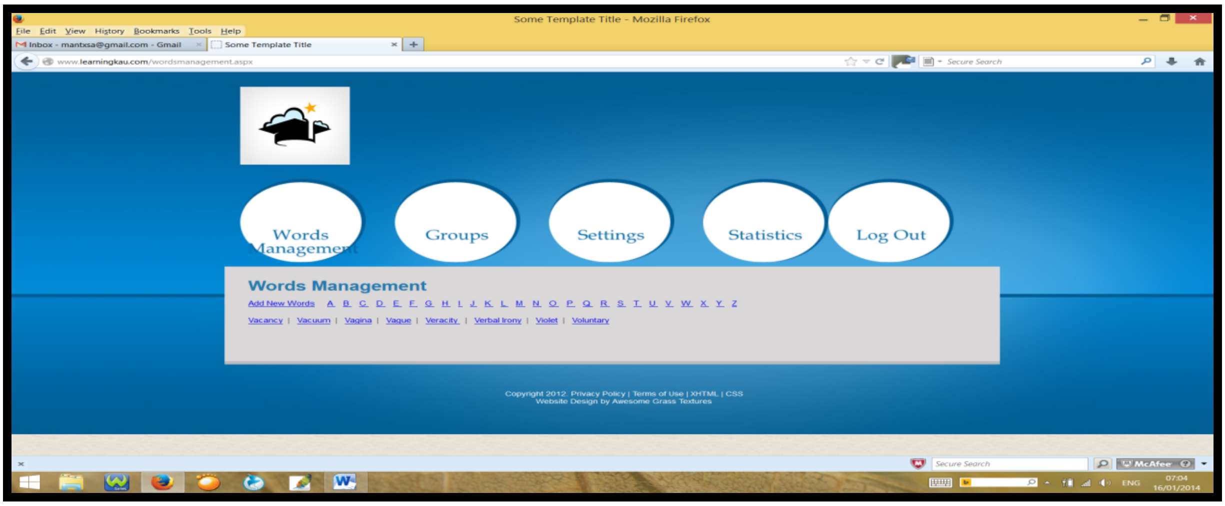


Figure 73: Word management listing with letter V

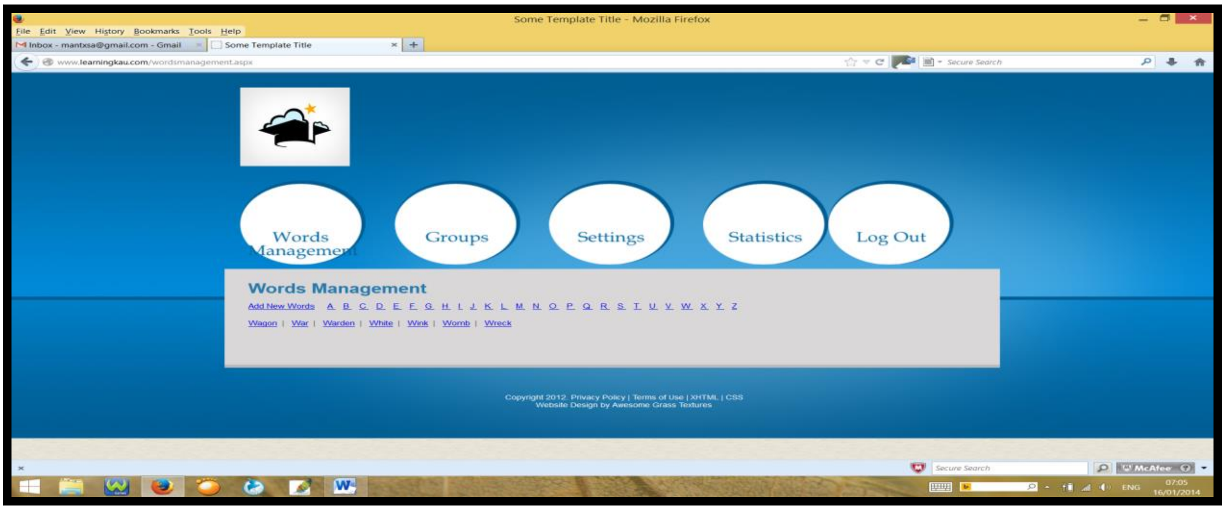


Figure 74: Word management listing with letter W

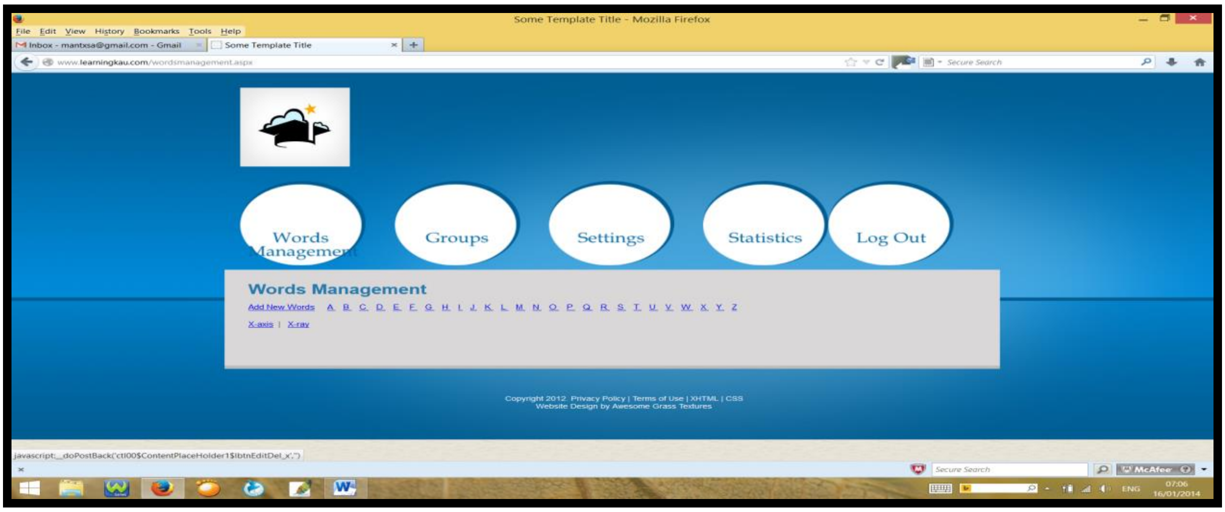


Figure 75: Word management listing with letter X

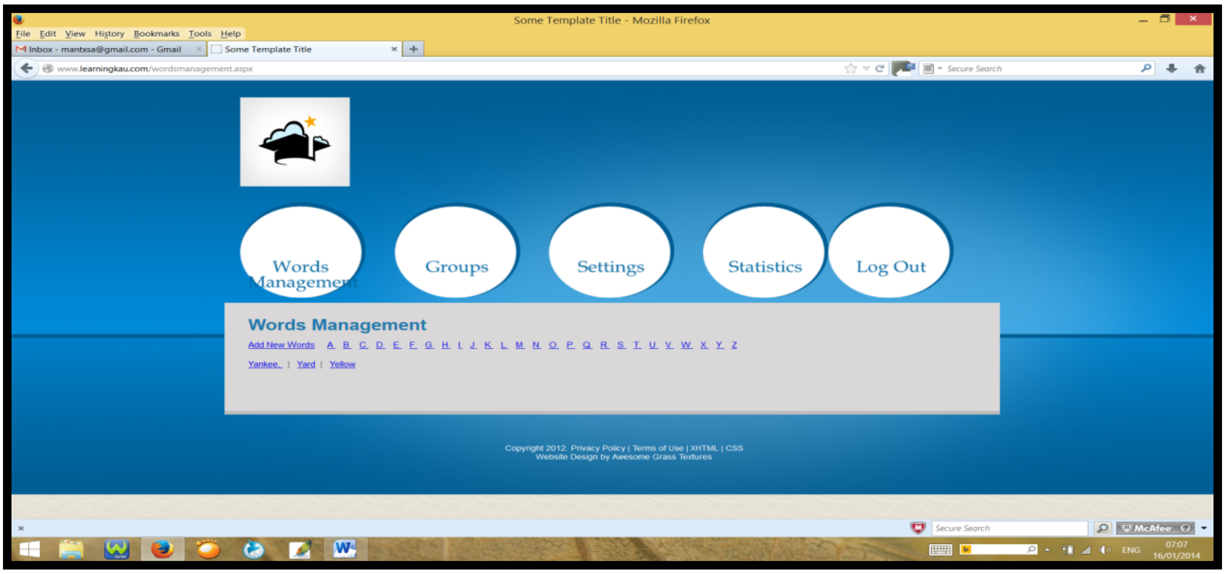


Figure 76: Word management listing with letter Y

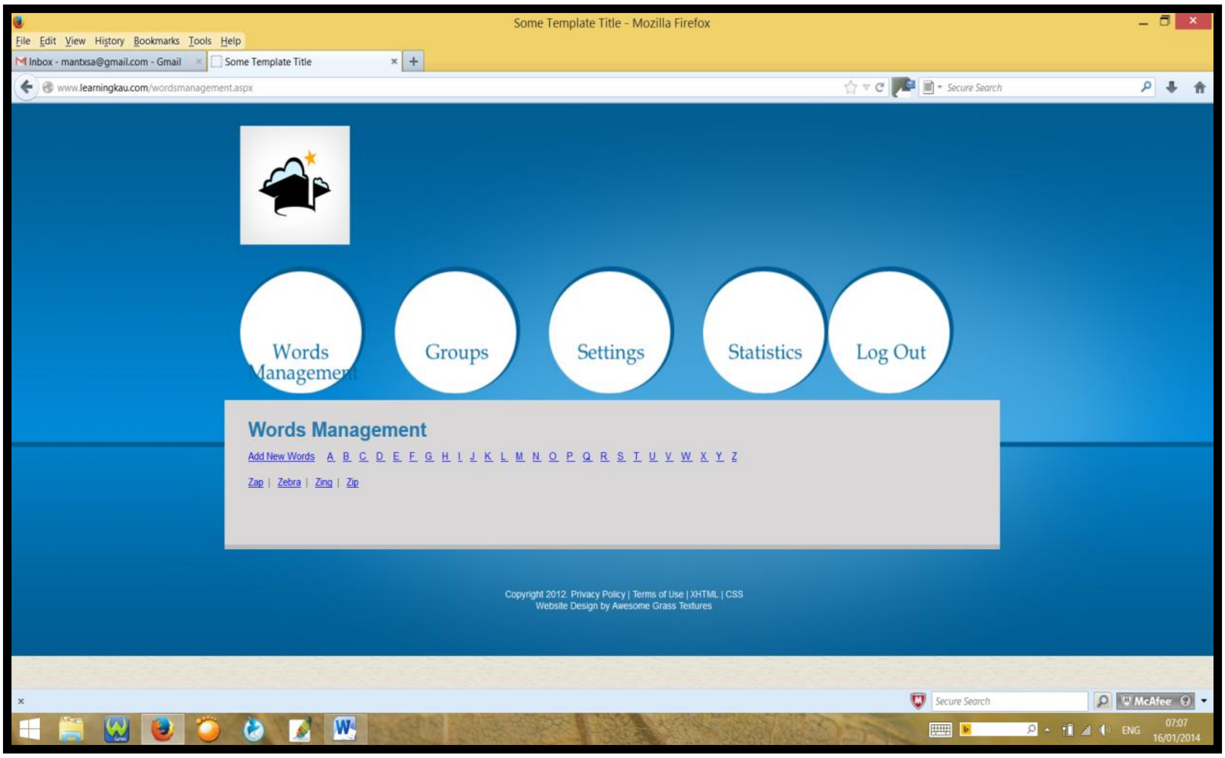


Figure 77: Word management listing with letter Z

Appendix C: All referencing for table: 3- Adaptive presentation: methods, technique and system

Adaptive HyperMan (MathÈ & Chen, 1994, MathÈ & Chen, 1996),
Anatom-Tutor (Beaumont, 1994),
Basar (Thomas, 1995; Thomas & Fischer, 1996),
C-Book (Kay & Kummerfeld, 1994a; Kay & Kummerfeld, 1994b),
CID (Boy, 1991),
[Clibbon] (Clibbon, 1995),
DHS (Shibata & Katsumoto, 1993; Katsumoto et al., 1994; Katsumoto et al., 1996),
ELM-ART (Brusilovsky, Schwarz & Weber, 1996; Schwarz, Brusilovsky & Weber, 1996),
ELM-PE (Brusilovsky & Weber, 1996),
EPIAIM (de Rosis et al., 1993; de Rosis, De Carolis & Pizzutilo, 1994),
Hynecosum (Vassileva, 1994, Vassileva, 1996),
Hypadapter (Bocker et al., 1990; Hohl, Bocker & Gunzenhauser, 1996),
HYPERCASE (Micarelli & Sciarrone, 1996),
HYPERFLEX (Kaplan et al., 1993),
HyperTutor (PÈrez et al., 1995; PÈrez et al., 1995),
HyPLAN (Fox, Grunst & Quast, 1993; Grunst, 1993),
ISIS-Tutor (Brusilovsky & Pesin, 1994; Brusilovsky & Pesin, 1995),
ITEM/PG (Brusilovsky, Pesin & Zyryanov, 1993; Brusilovsky & Zyryanov, 1993),
KN-AHS (Kobsa et al., 1994),
Land Use Tutor (Kushniruk & Wang, 1994),
Lisp-Critic (Fischer et al., 1990),
Manuel Excel (de La Passardiere & Dufresne, 1992)
MetaDoc (Boyle & Encarnacion, 1994),
ORIMUHS (EncarnaÁ„o, 1995a; EncarnaÁ„o, 1995b),
PUSH (Hˆˆk et al., 1996),
SYPROS (Gonschorek & Herzog, 1995)
SHIVA (Zeiliger, 1993),
WebWatcher (Armstrong et al., 1995),
WING-MIT (Kim, 1995)

Appendix D: Questionnaire for Experiment Two

Part 1	Questionnaire

D.1 Pre-Experimental Questions

We are investigating the use of different software interaction approaches and we would like to obtain your views about the use of such interactions. We compare two conditions: static and customises (for more explanation, see the terminology). Each was implemented in separate systems.

Terminology

Static: The interface and content does not change over time.
Customisation: The interface and content change over time by user.

I would be grateful if you could fill out the following questionnaire sincerely and provide your views. Thank you for your participation.

Part 1 Pre-Session Questionnaire

1. What is your gender?
   (1) Male
   (2) Female[149]

2. Please choose your highest level of education (highest degree you received) from the list below.
   (1) High School Graduate.
   (2) Some College/University.
   (3) College/University.
   (4) Post Graduate.

3. What is your mother language?
   (1) Arabic
   (2) English
   (3) French
   (4) Other

4. How long have you been using the Internet?
   (1) 6 to 12 months
   (2) 1 to 3 years
   (3) 4 to 6 years
   (4) 10 years or more

5. Please choose your age group:
   (1) 18–30
   (2) 30–40
   (3) 40–50
   (4) 50+

6. Do you ever change software settings?
   (1) No, never.
   (2) Yes, every time I use new software
   (3) Yes, when I need to
   (4) Yes, when I get some errors

Appendix E: Database design for the system

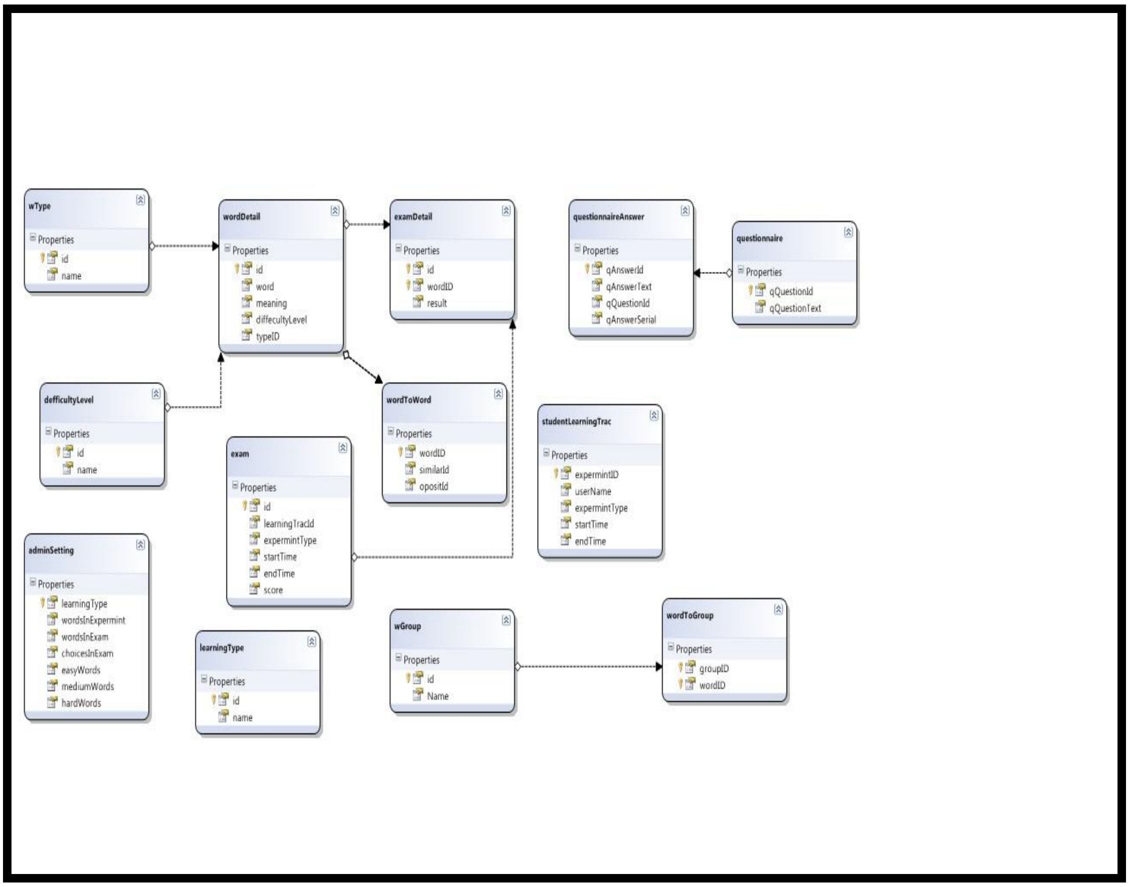


Figure 78: System database structure

Appendix F: Randomised word list for three comparative systems

Table 98: Words list for pilot study

Disposal (E)
Hover (E)
Kitten (E)
Denotation (M)
Appealing (M)
Boggles (M)
Decades (E)
Exclaim (M)
Polite (E)
Human (E)
Tangle (E)
Feature (E)
Awful (E)
Decent (E)
Interrupt (M)
Bias (E)
Insult (E)
Collection (E)
Urban (M)
Burdensome (D)
Torsion (D)
Empirical (M)
Accumulation (D)
Cumbersome (D)
Personification (D)
Simulation (E)
Modest (M)
Commodity (M)
Cooper (E)
Abundance (D)
Appreciation (D)
Inclination (D)
Perspicuity (D)
Medieval (M)
Vague (E)
Forsake (M)
Tendency (M)
Accordance (D)
Totalitarian (D)
Affirmation (D)

E=Easy, M=Moderate and D=Difficult

Appendix G: Randomised word list complexity and system used

Table 99: Word list and complexity for three systems

Words		
Easy (using Static system)	**Moderate (using Adaptable system)**	**Difficult (using Adaptive system)**
React (E)	Feign (M)	Egregious (D)
Hover (E)	Fluent (M)	Figment (D)
Polite (E)	Appreciation (M)	Inclination (D)
Accident (E)	Appreciation (M)	Augment (D)
Cocept (E)	Chronicle (M)	Capacious (D)
Law (E)	Boggles (M)	Perennial (D)
Decades (E)	Decades (M)	Chronological (D)
Receive (E)	Exclaim (M)	Agnostic (D)
Fact (E)	Clamour (M)	Corpulent (D)
Human (E)	Recognize (M)	Credulous (D)
Cost (E)	Tangle (M)	Tangle (D)
Feature (E)	Capable (M)	Excursion (D)
Awful (E)	Posture (M)	Doctrine (D)
Decent (E)	Decent (M)	Orthodox (D)
Interrupt (E)	Interrupt (M)	Doccile (D)
Bias (E)	Podium (M)	paradox (D)
Insult (E)	Insult (M)	Effigy (D)
Collection (E)	Collection (M)	Fidelity (D)
Animal (E)	Urban (M)	Superfluous (D)
Adjust (E)	Burdensome (M)	Inexorable (D)
Mental (E)	Portage (M)	Fallacious (D)
Missive (E)	Sensation (M)	Deleterious (D)
Accumulation (E)	Accumulation (M)	Inexorable(D)
Synonym (E)	Cumbersome (M)	Inimical (D)
Query (E)	Personification (M)	Hegemony (D)
Ensure (E)	Simulation (M)	Fracture (D)
Testify (E)	Modest (M)	Cacophony (D)
Continue (E)	Commodity (M)	Commodity (D)
Content (E)	Unison (M)	Couundrum (D)
Minor (E)	Abundance (M)	Grandiloquence (D)
Memory (E)	Appreciation (M)	Appreciation (D)
Legal (E)	Inclination (M)	Egregious (D)
Reject (E)	Perspicuity (M)	Perspicuity (D)
Factory (E)	Medieval (M)	Deleterious (D)
Figure (E)	Vague (M)	Abrogate (D)
Doctor (E)	Forsake (M)	Anathema (D)
Increase (E)	Tendency (M)	Effulgent (D)
Create (E)	Accordance (M)	Adumbrate (D)
Succeed (E)	Totalitarian (M)	Acrimony (D)
Exceed (E)	Torsion (M)	Abjure (D)

E=Easy, M=Moderate and D=Difficult

Appendix H: Raw Data of Achievement Test on Four systems

Table 100: Achievement test list 1= correct, 0 = incorrect

Student No	W 1	W 2	W 3	W 4	W 5	W 6	W 7	W 8	W 9	W 10	W 11	W 12	W 13	W 14	W 15	W 16	W 17	W 18	W 19	W 20	W 21	W 22
S1	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	1	1	1
S2	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0
S3	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0
S4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
S5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S6	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
S7	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1
S8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0
S11	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1
S12	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
S13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
S15	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1
S16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S17	1	1	0	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1
S18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S20	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S21	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S23	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S24	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 101: Raw data continuation of achievement test

Student No	W 23	W 24	W 2 5	W 26	W 27	W 28	W 29	W 30	W 31	W 32	W 33	W 34	W 35	W 36	W 37	W 38	W 39	W 40	All	Score
S1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	32	80%
S2	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	34	87.50%
S3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	36	90%
S4	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	38	95%
S5	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	39	97.50%
S6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	38	95%
S7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	92.50%
S8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	39	97.50%
S9	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	38	95%
S10	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	0	1	1	36	90%
S11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	35	87.50%
S12	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	38	95%
S13	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	37	92.50%
S14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	38	95%
S15	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	36	90%
S16	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	38	95%
S17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	92.50%
S18	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	39	97.50%
S19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	40	100%
S20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	38	95%
S21	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	37	92.50%
S22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	38	95%
S23	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	38	95%
S24	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	37	92.50%
Num C	22	21	21	23	22	22	22	24	22	22	22	21	23	23	23	23	23	23	819	85..31%
Num C	23	24	22	20	22	23	21	23	24	22	24	22	20	21	24	22	22	23	/	X
Nun C	22	22	24	22	23	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Correct Percent-age	92 %	87.5 %	87.5 %	96 %	92 %	92 %	92 %	100 %	92 %	92 %	84 %	96 %	96 %	96 %	96 %	96 %	100 %	92 %	960	X
	83 %	92 %	96 %	87.5 %	96 %	100 %	92 %	100 %	92 %	83 %	87.5 %	100 %	92 %	92 %	96 %	92 %	92 %	100 %	X	X
	92 %	96 %	96 %	79.2 %	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 102: Data achievement test for static system

Test Achievements at Static System							
Test Results					Scores		
Student No	Simple W	Moderate W	Difficult W		Simple W	Moderate W	Difficult W
St 1	12	9	19		30%	23%	48%
St 2	15	12	13		38%	30%	33%
St 3	20	10	10		50%	25%	25%
St 4	22	9	9		55%	23%	23%
St 5	12	13	15		30%	33%	38%
St 6	10	20	10		25%	50%	25%
St 7	15	17	8		38%	43%	20%
St 8	13	9	18		33%	23%	45%
St 9	9	16	15		23%	40%	38%
St 10	14	13	13		35%	33%	33%
St 11	12	13	15		30%	33%	38%
St 12	11	22	7		28%	55%	18%
St 13	14	8	18		35%	20%	45%
St 15	16	9	15		40%	23%	38%
St 16	22	7	11		55%	18%	28%
St 17	17	7	16		43%	18%	40%
St 18	15	17	8		38%	43%	20%
St 19	16	15	9		40%	38%	23%
St 20	14	16	10		35%	40%	25%
St 21	12	11	17		30%	28%	43%
St 22	13	15	12		33%	38%	30%
St 23	16	12	12		40%	30%	30%
St 24	9	11	20		23%	28%	50%
Total W	329	291	300		34%	30%	31%
Total CW	76%	69%	50%		250	200	150
A v	14	12	13		X	X	X

Table 103: Data achievement for adaptable system

Test Achievements at Adaptable System												
Test Results								Scores				
Student No	Simple W	Moderate W	Difficult W	Antonyms W	Synonym W	All		Simple W	Moderate W	Difficult W	Antonyms W	Synonym W
St 1	7	5	10	7	11	40		18%	13%	25%	18%	28%
St 2	8	6	4	9	13	40		20%	15%	10%	23%	33%
St 3	5	10	10	5	10	40		13%	25%	25%	13%	25%
St 4	4	9	9	6	12	40		10%	23%	23%	15%	30%
St 5	7	8	10	9	6	40		18%	20%	25%	23%	15%
St 6	10	2	10	8	10	40		25%	5%	25%	20%	25%
St 7	7	10	8	10	5	40		18%	25%	20%	25%	13%
St 8	5	9	10	10	6	40		13%	23%	25%	25%	15%
St 9	8	9	12	8	3	40		20%	23%	30%	20%	8%
St 10	3	10	13	10	4	40		8%	25%	33%	25%	10%
St 11	10	10	10	6	4	40		25%	25%	25%	15%	10%
St 12	1	9	7	12	11	40		3%	23%	18%	30%	28%
St 13	5	8	9	8	10	40		13%	20%	18%	20%	25%
St 15	9	6	10	6	9	40		23%	15%	25%	15%	23%
St 16	6	7	11	8	8	40		15%	18%	28%	20%	20%
St 17	9	7	8	10	9	40		23%	18%	20%	25%	23%
St 18	6	9	8	11	6	40		15%	23%	20%	28%	15%
St 19	4	7	9	10	10	40		10%	18%	23%	25%	25%
St 20	8	6	8	10	8	40		20%	15%	20%	25%	20%
St 21	4	11	11	7	7	40		10%	28%	28%	18%	18%
St 22	10	10	9	5	6	40		25%	25%	%	13%	15%
St 23	8	12	10	7	3	40		20%	30%	25%	18%	8%
St 24	9	11	7	3	10	40		23%	28%	18%	8%	25%
Total W	153	191	213	185	181	X		16%	20%	22%	19%	19%
Total C	59%	40%	25%	57%	55%	X		90	77	54	105	99
AV	6	8	9	8	8	X		X	X	X	X	X

Table 104: Data achievement for adaptive system

Test Achievements at Adaptive System												
Test Results								Scores				
Student No	Simple W	Moder-ate W	Diffi-cult W	Anto-nyms W	Syno-nym W	All		Simple W	Moder-ate W	Dif-ficult W	anto-nyms W	Syno-nym W
St 1	7	9	10	9	5	40		18%	23%	25%	23%	13%
St 2	9	6	9	10	6	40		23%	15%	23%	25%	15%
St 3	11	9	10	5	5	40		28%	23%	25%	13%	13%
St 4	5	6	5	9	15	40		13%	15%	13%	23%	38%
St 5	7	10	10	8	5	40		18%	25%	25%	20%	13%
St 6	3	7	9	11	10	40		8%	18%	23%	28%	25%
St 7	9	8	8	8	7	40		23%	20%	20%	20%	18%
St 8	8	7	6	10	9	40		20%	18%	15%	25%	23%
St 9	10	10	10	6	4	40		25%	25%	25%	15%	10%
St 10	12	5	5	8	10	40		30%	13%	13%	20%	25%
St 11	9	10	8	5	8	40		23%	25%	20%	13%	20%
St 12	6	6	7	15	6	40		15%	15%	18%	38%	15%
St 13	6	8	12	4	10	40		15%	20%	13%	10%	25%
St 15	4	9	10	8	9	40		10%	23%	25%	20%	23%
St 16	10	5	4	11	10	40		25%	13%	10%	28%	25%
St 17	5	7	9	15	4	40		13%	18%	23%	38%	10%
St 18	7	9	8	6	10	40		18%	23%	20%	15%	25%
St 19	11	10	6	4	9	40		28%	25%	15%	10%	23%
St 20	8	9	10	6	7	40		20%	23%	25%	15%	18%
St 21	6	7	7	10	10	40		15%	18%	18%	25%	25%
St 22	3	8	10	11	8	40		8%	20%	25%	28%	20%
St 23	6	9	6	12	7	40		15%	23%	15%	28%	23%
St 24	5	10	9	8	8	40		13%	25%	23%	20%	20%
Total W	167	184	188	199	182	X		17%	19%	20%	21%	19%
Total C	39%	30%	23%	73%	46%	X		65	56	44	145	85
AV	7	8	9	8	8	X		X	X	X	X	X

Table 105: Data achievement for mixed-initiative system

Test Achievements at Mixed-Initiative System												
Test Results								Scores				
Student No	S8imple W	Moderate W	Difficult W	antonyms W	Synonym W	All		Simple W	Moderate W	Difficult W	antonyms W	Synonym W
St 1	2	7	9	12	10	40		5%	18%	23%	30%	25%
St 2	11	5	7	10	7	40		28%	13%	18%	25%	18%
St 3	5	5	10	9	11	40		13%	13%	25%	28%	28%
St 4	9	5	9	5	12	40		23%	13%	23%	23%	30%
St 5	7	6	8	11	8	40		18%	15%	28%	28%	20%
St 6	9	7	10	6	8	40		13%	18%	15%	15%	20%
St 7	4	11	9	6	10	40		10%	28%	23%	15%	25%
St 8	6	9	10	8	7	40		15%	23%	25%	20%	18%
St 9	5	7	13	5	10	40		13%	18%	33%	13%	25%
St 10	6	7	10	7	10	40		15%	18%	25%	18%	25%
St 11	7	5	9	10	9	40		18%	13%	23%	25%	23%
St 12	3	6	9	10	12	40		8%	15%	23%	25%	30%
St 13	3	9	10	9	9	40		8%	23%	25%	23%	23%
St 15	5	11	9	8	7	40		13%	28%	23%	20%	18%
St 16	5	11	7	8	9	40		13%	28%	18%	20%	23%
St 17	8	10	9	9	3	40		20%	25%	23%	23%	8%
St 18	7	9	5	10	9	40		18%	23%	13%	25%	23%
St 19	8	9	10	9	4	40		20%	23%	25%	23%	10%
St 20	6	7	9	5	13	40		15%	18%	23%	13%	33%
St 21	7	8	9	7	9	40		18%	20%	23%	18%	23%
St 22	5	6	8	11	10	40		13%	15%	20%	28%	25%
St 23	8	6	10	3	13	40		20%	15%	25%	8%	33%
St 24	5	9	8	6	12	40		13%	23%	20%	15%	30%
Total W	141	175	207	184	212	X		24%	24.2%	46%	74%	85%
Co W	50%	34%	27%	36%	43%	X		70	60	55	67	92
AV	6	7	9	8	9	X		X	X	X	X	X

Appendix I: Word List Survey for level of difficulties

Dear Students:

For purposes of my research, it is necessary to categorise these words and their meanings. Please indicate only the letter between the brackets.

Difficult = D, In-between = M, and Easy = E

Words		*Meaning*
1.	React	to act in response to something. ( )
2.	Agent	something which acts or acts upon something else. ( )
3.	Agitate	to excite, to disturb, to stir up. ( )
4.	Audible	can be heard. ( )
5.	Amicable	friendly. ( )
6.	Animal	a living creature. ( )
7.	Animate	to give spirit or support, to supply movement. ( )
8.	Animosity	hostility, ill will. ( )
9.	Annuity	money payable yearly. ( )
10.	Anniversary	the yearly celebration of an event. ( )
11.	Perennial	enduring, persisting for several years. ( )
12.	Author	one that originates or creates a writer. ( )
13.	Augment	to increase, to add to. ( )
14.	Auction	a sale of goods to the highest bidder. ( )
15.	Benign	harmless, mild, gentle. ( )
16.	Abbreviate	to shorten. ( )
17.	Brevity	short or concise expression. ( )
18.	Deceive	to cause or allow someone to believe something is true when it is actually false; to mislead. ( )
19.	Capable	having the ability to do something; having the traits necessary to perform some action.( )
20.	Capacious	containing a great deal. ( )
21.	Captive	a person held against his or her own will; held prisoner. ( )
22.	Accident	an unplanned event. ( )
23.	Receive	to take in, to acquire. ( )
24.	Concept	an idea. ( )
25.	Predecessor	a person who has previously occupied a position that another has taken over. ( )
26.	Succeed	to follow after another, to do well. ( )
27.	Recede	to move back, to withdraw. ( )
28.	Concede	to accept as true, to yield, to allow. ( )
29.	Exceed	to go beyond a limit, to be greater than. ( )
30.	Recess	an indentation, a temporary break. ( )
31.	Deceased	dead. ( )
32.	Chronic	marked by a long period of time, recurrence. ( )
33.	Chronicle	a historical account arranged in order of time. ( )
34.	Chronological	arranged in order of time. ( )
35.	Acclaim	praise. ( )

36.	Exclaim	to speak loudly, to cry out in surprise. ( )
37.	Clamour (n).	noise, (v). To make noise. ( )
38.	Proclaim	to declare loudly. ( )
39.	Cognizant	aware. ( )
40.	Diagnose	to recognise (diseases) by symptoms. ( )
41.	Agnostic	one who believes that any ultimate reality is unknowable.()
42.	Recognize	to know, to identify. ( )
43.	Corpse	a dead body. ( )
44.	Corpulent	having a large body. ( )
45.	Incorporate	to unite into one being. ( )
46.	Corporate	formed into a body or association, united in one group. ( )
47.	Crescent	a narrow curved shape; a quarter moon or smaller. ( )
48.	Create	to originate, to produce through imagination. ( )
49.	Accretion	growth by gradual addition. ( )
50.	Increase	to grow in size or amount. ( )
51.	Credible	can be believed, reasonable. ( )
52.	Credulous	too ready to believe. ( )
53.	Incredible	unbelievable, amazing. ( )
54.	Excursion	a trip. ( )
55.	Discourse	a conversation, to talk. ( )
56.	Courier	a messenger. ( )
57.	Course	forward movement, movement from point to point; to run along a path.( )
58.	Occur	to happen, to come to mind. ( )
59.	Current	happening now, up to date; the movement of water.( )
60.	Dictionary	a book of definitions. ( )
61.	Condition	the state of something or someone. ( )
62.	Indicate	to show, to point out. ( )
63.	Dictate	to speak for a person to record, to issue an order. ( )
64.	Predict	to say what will happen in the future. ( )
65.	Addict	to be devoted to something in an obsessive manner. ( )
66.	Doctor	a person who has received the highest degree a university offers, a physician.( )
67.	Doctrine	something that is taught, dogma. ( )
68.	Docile	obedient, easily taught. ( )
69.	Document	an official paper. ( )
70.	Orthodox	holding conventional beliefs. ( )
71.	Dogma	an established opinion. ( )
72.	Paradox	a statement that seems to contradict itself but contains some truth. ( )
73.	Decorate	to make something look attractive or suitable. ( )
74.	Decent	conforming to standards, good, kind. ( )
75.	Dignity	quality of being worthy, noble, honoured. ( )
76.	Conduct	(v). to lead or guide, (n). A person’s behaviour. ( )
77.	Educate	to train, to provide schooling for. ( )
78.	Induct	to install in office or to enrol in military by service. ( )
79.	Deduct	to subtract. ( )
80.	Deduce	to make a decision or draw a conclusion by reasoning. ( )
81.	Produce	to bring forward, to make, to bear or yield; something made or grown. ( )
82.	Seduce	to persuade (especially into doing something wrong), to tempt. ( )

83.	Induce	to persuade, cause, or bring about by artificial means. ( )
84.	Eternal	not affected by time, without beginning or end, ceaseless.()
85.	Medieval	relating to the middle Ages (500–1500 AD). ( )
86.	Faint	indistinct, not clearly perceived, weak; to lose consciousness from lack of blood to the brain.( )
87.	Feign	to pretend. ( )
88.	Fiction	something produces from imagination, an invented story.( )
89.	Effigy	a figure representing a disliked person. ( )
90.	Figure	shape, pattern, or drawing. ( )
91.	Figment	a thing that does not exist, something made up. ( )
92.	Feature	the appearance or form of a person or object; to picture, portray.( )
93.	Factory	a place where things are made or built. ( )
94.	Difficult	hard to do, troublesome, hard to understand. ( )
95.	Fact	something known to be true. ( )
96.	Effect	a change caused by something, a result, influence. ( )
97.	Fertile	productive, bearing or capable of bearing fruit in large quantities.( )
98.	Refer	to classify within a general category, to send or direct to another source. ( )
99.	Infer	to come to a conclusion from facts or ideas, to guess. ( )
100.	Diffident	hesitant in acting, shy. ( )
101.	Fidelity	the quality of being faithful, accuracy. ( )
102.	Confide	to trust, to trust another person with a secret. ( )
103.	Fluent	capable of moving with ease, able to speak another language. ( )
104.	Superfluous	extra, more than is needed. ( )
105.	Influence	to have an effect on something; the ability to affect something indirectly. ( )
106.	Fluid	capable of flowing, a smooth style, liquid. ( )
107.	Fluctuate	to shift back and forth, to move erratically. ( )
108.	Formulate	to prepare from a set of steps, formula to devise. ( )
109.	Fracture	to break, to crack; a broken bone. ( )
110.	Fragment	a piece broken off, a part of something. ( )
111.	Frail	easily broken, not strong. ( )
112.	Generally	in a general manner, usually, with regard to the whole. ( )
113.	Gingerly	careful. ( )
114.	Indigenous ( )	native, having been born in a specific area or environment.
115.	Graffiti	drawings or writing on a wall. ( )
116.	Adhere	to stick. ( )
117.	Hesitate	to hold back a decision, to waver. ( )
118.	Reject	to throw out, unwilling to accept. ( )
119.	Adjust	to change or adapt to fit or match something. ( )
120.	Conjugal	of marriage, marital relationship. ( )
121.	Junction	the place at which two things joins. ( )
122.	Legal	based on law; conforms to law. ( )
123.	League	a group of people, an association. ( )
124.	Legible	readable, clear enough to read. ( )
125.	Eligible	qualified, worthy to be chosen. ( )
126.	Illuminate	to provide with light, to make lighter, to make clear. ( )

127.	Illustrate	to explain by using pictorial examples, to show by using visual examples. ( )
128.	Memory	the ability to recall past events. ( )
129.	Mental	related to the mind. ( )
130.	Mention	to cite, to speak about, and to refer to.( )
131.	Minor	lesser, less important. ( )
132.	Minute	tiny, very small; sixty seconds. ( )
133.	Minuscule	very small. ( )
134.	Missive	a letter to be sent. ( )
135.	Mobile	able to move. ( )
136.	Motion	act of moving, action. ( )
137.	Nascent	just born. ( )
138.	Pregnant	having a child developing in the womb, "with child". ( )
139.	Naive	lack of experience, not knowledgeable of the world.( )
140.	Synonym	a word with a similar meaning to another word in the same language. ( )
141.	Novice	a newcomer, a beginner, someone new to something.( )
142.	Opus	a musical composition. ( )
	Passion	a strong feeling or emotion. ( )
143.	Sympathy	sharing another person's feelings, the ability to feel for a other person's suffering. ( )
144.	Pathology	the study of diseases. ( )
145.	Pedestal	a support for a column or other structure, a base for some thing.( )
146.	Pedestrian	a person walking. ( )
147.	Podium	a platform, an area raised above the surrounding ground, a place from which to speak in front of an audience. ( )
148.	Pulse	the regular action of blood through arteries. ( )
149.	Suspend	to hang from, to interrupt, and to stop. ( )
150.	Ponder	to think about, to weigh in one's mind. ( )
151.	Fantasy	a creation of the imagination that cannot be real, a da dream. ( )
152.	Portage	the labour of carrying boats across land. ( )
153.	Implicate	to involve, incriminating. ( )
154.	Postpone	to put off to a later time. ( )
155.	Posture	the position of a body. ( )
156.	Exquisite	carefully selected, marked by beauty. ( )
157.	Quest	a search, the act of seeking. ( )
158.	Query	to ask questions, a question. ( )
159.	Rupture	to break or burst. ( )
160.	Interrupt	to stop, to break in (usually with questions). ( )
161.	Science	a system of knowledge. ( )
162.	Scribble	to write quickly or carelessly. ( )
163.	Script	handwriting, something written. ( )
164.	Describe	to say what something is like. ( )
165.	Sensation	ability to feel due to stimulation. ( )
166.	Sentimental	marked by feeling or emotion. ( )
167.	Consecutive	following in an unbroken order. ( )
168.	Ensue	to happen afterward. ( )
169.	Isolate	to separate from others, to place something by itself.( )

170.	Absolute	complete, unrestricted, perfect. ( )
171.	Soluble	able to disperse in liquid. ( )
172.	Despise	to hate, to look down on. ( )
173.	Auspicious	favourable. ( )
174.	Espionage	using spies or observers. ( )
175.	Inspire	to stimulate, to fill with a feeling or desire. ( )
176.	Establish	to found, to start, to make firm. ( )
177.	Stance	a way of standing, a position, an attitude. ( )
178.	Constrict	to squeeze, to make narrow. ( )
179.	Stringent	strict, tight, severe. ( )
180.	Prestige	respect for a person or a thing. ( )
181.	Misconstrue	to interpret, analyse, or understand something incorrectly; misunderstand. ( )
182.	Obstruct	to block, prevent, hinder. ( )
183.	Tangible	able to be perceived by touch, physically real. ( )
184.	Contiguous	touching, next in a sequence. ( )
185.	Contingent	possible, dependent on something else. ( )
186.	Contend	to strive or reach for, to argue. ( )
187.	Continue	to keep going, to remain. ( )
188.	Content	something contained held; satisfied. ( )
189.	Tenacious	holding or sticking to something. ( )
190.	Terminal	relating to an end. ( )
191.	Testify	to make a statement based on personal knowledge. ( )
192.	Torsion	twisting of a body or an organ by an external force along an axis.( )
193.	Unison	at the same time, at the same pitch. ( )
194.	Vacuum	empty space, isolation from outside influence. ( )
195.	Invent	to create through thought or imagination.( )
196.	Veracity	truthfulness, accuracy. ( )
197.	Adumbrate	(v.) to sketch out in a vague way ( )
198.	Acumen	(n.) keen insight.
199.	Anathema	(n.) a cursed, detested person. ( )
200.	Cacophony	(n.) tremendous noise, disharmonious sound. ( )
201.	Conundrum	(n.) puzzle, problem. ( )
202.	Decry	(v.) to criticize openly. ( )
203.	Defile	(v.) to make unclean, impure. ( )
204.	Effulgent	(adj.) radiant, splendorous. ( )
205.	Egregious	(adj.) extremely bad. ( )
206.	Evanescent	(adj.) fleeting, momentary. ( )
207.	Fallacious	(adj.) incorrect, misleading. ( )
208.	Grandiloquence	(n.) lofty, pompous language. ( )
209.	Hegemony	(n.) domination over others. ( )
210.	Inexorable	(adj.) incapable of being persuaded or placated. ( )
211.	Inimical	(adj.) hostile. ( )
212.	Valetudinarian	(n.) a person excessively worried about the state of his health, hypochondriac. ( )
213.	Hypnopompic	(adj.) of or relating to the partially conscious state that proceeds complete awakening from sleep. ( )
214.	Myrmidon	(n.) a person who executes without question or scruple a master's commands. ( )

List of Published Papers

The following publication has been delivered:

Conference Paper

Alshumari M. Giampaolo B. (2014): "Online English Vocabulary Learning on Different Systems for Non-English Speakers". In Proceedings ELMAR-2014, 56th International Symposium, IEEE, pp. 293–296, Zadar, Croatia, ISBN: 978-953-184-199-3.